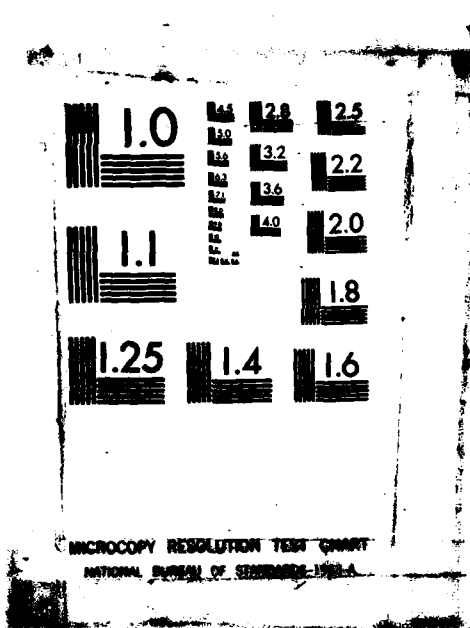


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THAMES RIVER BASIN
SOUTHBRIDGE, MASSACHUSETTS

RESERVOIR NO. 3 DAM
MA 00691

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

SEPTEMBER 1979

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number) DAMS, INSPECTION, DAM SAFETY, Thames River Basin Southbridge, Massachusetts Hatchat Brook		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The dam is about 490 ft. long excluding the spillway and has a maximum height of about 24 ft. The dam is considered to be in fair condition. The size is small and the hazard potential is significant. Investigations are recommended to determine the long-term stability of the embankment and the erosion during flood discharges.		



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:

NEDED

NOV 15 1973

Honorable Edward J. King
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts 02133

Dear Governor King:

Inclosed is a copy of the Reservoir No. 3 Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. In addition, a copy of the report has also been furnished the owner, Southbridge Water Supply Company.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Quality Engineering for your cooperation in carrying out this program.

Sincerely,

Max B. Scheider
MAX B. SCHEIDER

Colonel, Corps of Engineers
Division Engineer

Incl
As stated

RESERVOIR NO. 3
MA 00691

THAMES RIVER BASIN
SOUTHBRIDGE, MASSACHUSETTS

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Identification: MA 00691
Name of Dam: RESERVOIR NO. 3 DAM
Town: SOUTHBRIDGE
County and State: WORCESTER COUNTY, MA
Stream: HATCHET BROOK
Date of Inspection: 13 AUGUST 1979

BRIEF ASSESSMENT

Reservoir No. 3 Dam is approximately 490 feet long excluding the spillway and has a maximum height of approximately 24 feet. It consists of an earth embankment with riprap at the upstream face and a loamed and seeded crest and downstream face. A gatehouse is present at the center of the dam just upstream of the face of the crest. The 45 foot wide masonry spillway is located at the left abutment of the dam.

The facility is considered in fair condition. This classification is based on the observation of surficial sloughing at the downstream face and seepage at the embankment downstream toe. Minor repairs are required in the spillway and spillway discharge channel.

Based on the size classification, small, and hazard potential classification, significant, in accordance with Corps of Engineers Guidelines, the adopted spillway test flood is the 1/4 Probable Maximum Flood. Hydrologic analysis indicates that the spillway and emergency overflow capacity with the water surface at the top of the dam is approximately 890 cfs, which is greater than the total routed test flood outflow of 785 cfs. The estimated test flood stage is about 0.5 feet below the nominal top of dam.

Investigations are recommended to determine the long-term stability of the embankment and the erosion during flood discharges. Recommended remedial measures include the filling of animal burrows, the clearing of weeds, brush and debris from the downstream channels, the limiting of vehicle traffic on the dam, and the repair of minor deterioration at the spillway. The Owner should develop a formal maintenance program, operational procedure, and emergency procedures plan and should institute a program of annual technical inspections. The remedial measures and recommendations should be performed within one year of receipt of this report by the Owner.

CAMP DRESSER & MCKEE INC.

Roger H. Wood
Roger H. Wood
Vice President



1112

This Phase I Inspection Report on Reservoir No. 3 Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgement and practice, and is hereby submitted for approval.

Joseph W. Finegan
JOSEPH W. FINEGAN, JR., MEMBER
Water Control Branch
Engineering Division

Carney M. Terzian
CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

Joseph A. McElroy
JOSEPH A. MCELROY, CHAIRMAN
Chief, NED Materials Testing Lab.
Foundations & Materials Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar
JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I Investigations are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the test flood is based on the estimated "probable maximum flood" for the region (greatest reasonably possible storm runoff), or a fraction thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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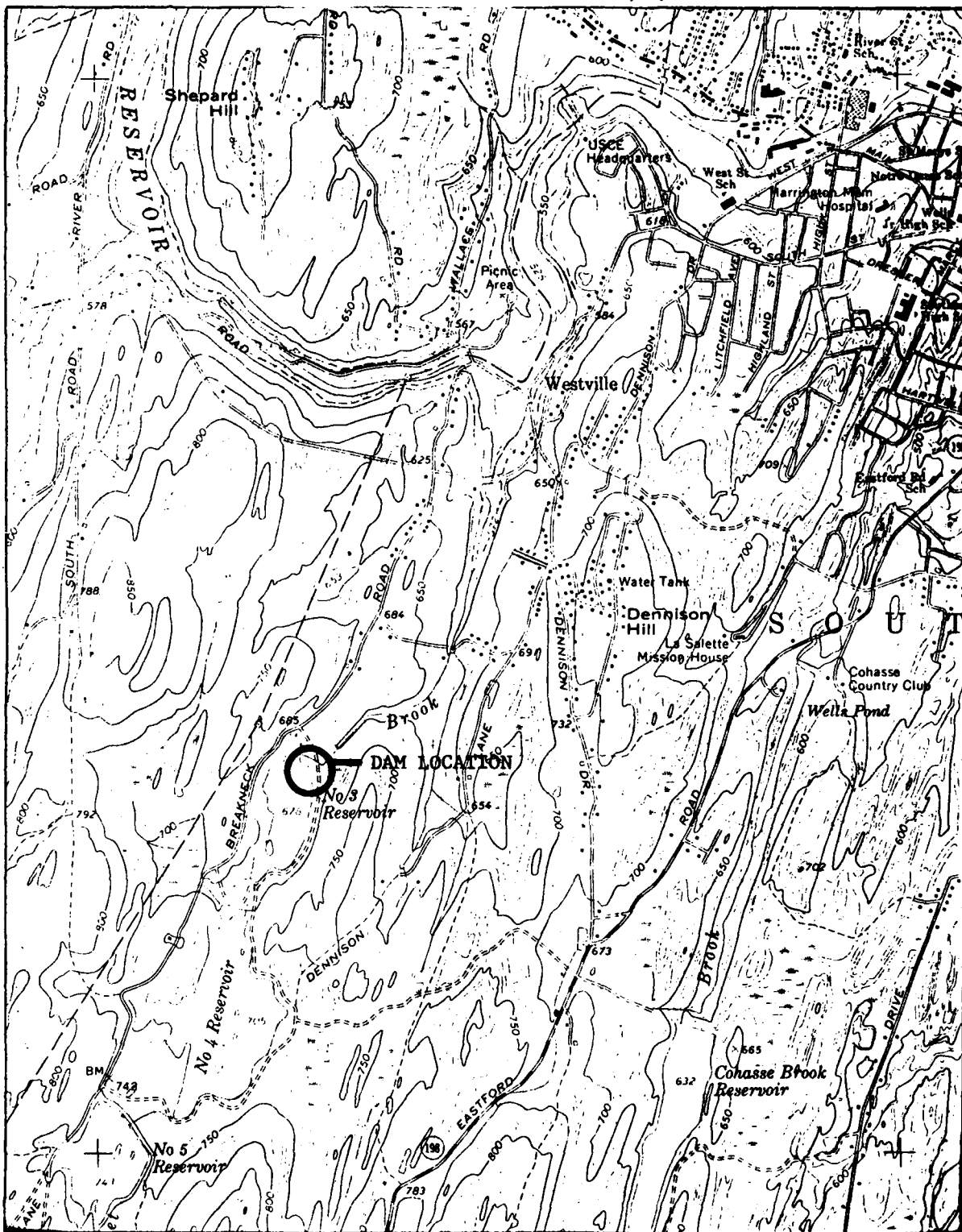
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1. OVERVIEW OF DAM FROM RIGHT ABUTMENT.



2. OVERVIEW OF DAM FROM LEFT ABUTMENT.



DAM RESERVOIR NO. 3

IDENTIFICATION NO. MA 00691



LOCATION MAP
USGS QUADRANGLE
SOUTHBRIDGE, MA - CONN.

APPROX. SCALE: 1" = 2000'

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

RESERVOIR NO. 3
MA 00691

SECTION 1: PROJECT INFORMATION

1.1 General

- a. Authority - Public Law 92-367, 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region.

Camp Dresser & McKee Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed was issued to Camp Dresser & McKee Inc. under a letter of 27 March 1979, from Colonel John P. Chandler, Corps of Engineers. Contract No. DACW 33-79-C-0053 has been assigned by the Corps of Engineers for this work. Haley and Aldrich, Inc. has been retained by Camp Dresser & McKee Inc. for the soils and geological portions of the work.

- b. Purpose - The primary purpose of the investigation is to:

- (1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-federal interests.
- (2) Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.
- (3) Update, verify and complete the National Inventory of Dams.

1.2 Description of Project

- a. Location - Reservoir No. 3 Dam is located on the east side of Breakneck Road in the Town of Southbridge, Massachusetts, as shown on the report's Location Map. The dam impounds the waters of Hatchet Brook to form Reservoir No. 3. Hatchet Brook flows from the dam to the Quinebaug River in the U.S. Corps of Engineers Westville Reservoir Flood Control impoundment area, a distance of approximately 6,000 feet downstream. The coordinates for the dam are 72 degrees-04.4 minutes longitude and 42 degrees-03.4 minutes latitude.
- b. Description of Dam and Appurtenances - Reservoir No. 3 consists of an earth embankment with a concrete corewall, a gatehouse near the center of the dam and a flat stone spillway at the left abutment.

The embankment is approximately 490 ft. long, has a maximum height of about 24 ft. and is 12 ft. wide at the crest. According to a drawing obtained from the County Engineer and included in Appendix B, the embankment is founded on "hard pan" and has a concrete corewall and two upstream cutoff trenches. Sheet piling is indicated beneath the corewall. Embankment materials are indicated to be "puddled gravel", with "rip rap" wave protection on the upstream face and "loam" on the crest and downstream face.

Embankment slopes are approximately 1.5H to 1V for the upstream face and the upper part of the downstream face. A rock fill was added in about 1920 to control sloughing of the downstream face. This fill has a downstream face slope of approximately 2H to 1V and extends about half way up the embankment, forming a narrow berm about mid-height on the dam.

The stone masonry spillway is 45.5 feet wide and has a 2.75 feet deep concrete weir. The approach and downstream channels are stone paved in the vicinity of the spillway crest. The spillway is located at the left abutment of the dam. There are eight iron posts about 1 foot high and set about 5 feet apart along the weir crest. The iron posts support a maximum of 12 inches of flashboards.

About 70 feet to the left of the spillway, there is a roughly defined depression along natural ground which serves as an emergency overflow during major flooding events. Its average crest elevation is 1.5 feet higher than the spillway.

The outlet works for the project is a 24-inch cast iron pipe located at the center of the dam. The outlet or drain pipe is screened and manually gated at the well in the gatehouse at the upstream face of the dam. The gatehouse is built on top of a stone substructure which forms a 5 foot by 5 foot intake well for both the drain pipe and a 16-inch cast iron water supply main. The drain pipe discharges into a stone channel which leads to a natural channel further downstream. The water main, which supplies the Town of Southbridge, feeds into a chlorination house at the toe of the dam just to the right of center.

- c. Size Classification - The maximum height of the dam is approximately 24 feet and the estimated total storage capacity at the top of the dam is 350 acre-feet. According to guidelines established by the Corps of Engineers, the dam is classified in the "small" category based on both storage capacity and height.
- d. Hazard Classification - The results of the dam failure analysis indicate that two roadways would be overtopped by 8.5 to 9 feet of water. A chlorination house, a chlorine storage building and a house would also be affected. In addition, day users of Westville Reservoir would be endangered by the flood wave. The potential loss of life would be a few persons. Consequently, the dam is classified in the "significant" hazard category.
- e. Ownership - The dam is owned by the Southbridge Water Supply Co. The owner is represented by Mr. Chester Spielvogel, Superintendent and Treasurer, 70 Foster Street, Southbridge, MA 01550 (Phone 617/764-3207).
- f. Operator - Mr. Maurice Comtois is assigned responsibility for operation of the dam. His business and home address is Breakneck Road, Southbridge, MA 01550 (Phone 617/764-98092).
- g. Purpose of the Dam - Reservoir No. 3 Dam provides for water storage and regulates its release as part of the water supply system for the Town of Southbridge, MA.
- h. Design and Construction History - The dam was designed in 1893 and constructed shortly thereafter. No records of the construction are available. A proposed design plan showing the general configuration of the dam and appurtenances is included in Appendix B. There was a major modification to the proposed design. The plan shows a 690 foot long dam with an angle point in its alignment after 490 feet. The present dam is a total of 490 feet long and the angle point after 475 feet is not as abrupt as shown on the design plan. The proposed original

spillway length of 50 feet was shortened to 45 feet. In the 1920's, rockfill with topsoil and sod was added to the downstream half of the dam in an effort to flatten the slope and reduce sloughing and erosion. In the 1930's, the spillway crest was raised 1 foot by placing a concrete weir on top of the existing cut stone masonry weir. In addition, provisions for 1 foot of flashboards were added to the spillway, as shown on Photo 6.

1. Normal Operating Procedure - Maintenance at the dam is performed on a routine schedule. There is a caretaker permanently assigned to the reservoir who has responsibility for the operation of the outlet works controls and weir flashboards on an as needed basis. The grass is cut twice a year at the dam and the 24-inch outlet works pipe is periodically operated.

- 1.3 Pertinent Data - There are no known elevations previously established at the dam site. Consequently, the water surface elevation of 678.0, shown on the USGS Quadrangle Southbridge, MA-CONN, 1967, was adopted as spillway crest elevation. All other elevations given in this report were estimated from the assumed spillway crest elevation. Elevations given in this report refer to National Geodetic Vertical Datum (NGVD) formerly referred to as Mean Sea Level.

- a. Drainage Area - The drainage area tributary to the dam is 2.4 square miles. The pond is surrounded by moderately sloped hills which are heavily forested. There is essentially no development in the drainage area with the exception of the caretaker's house and Breakneck Road along the western bank of Reservoir No. 3. Reservoir No. 3 accounts for approximately 1.5 percent of the total drainage area. Total upstream ponds account for about 6 percent of the total watershed.
- b. Discharge at Dam Site - Notable floods at the location occurred on 21 September 1938 and 18 March 1936. Estimated discharges based on records of high water elevations are 500 cfs and 310 cfs, respectively.
 - (1) Outlet works size: 24-inch C.I. pipe with 100 cfs capacity at Test Flood Elevation
 - (2) Maximum known flood at damsite.... 21 September 1938 with a stage of 680.9 and a discharge of 500 cfs.
 - (3) Ungated spillway capacity at top of dam 890 cfs @ 681.3 elev.

- (4) Ungated spillway capacity at test flood elevation 690 cfs @ 680.8 elev.
- (5) Gated spillway capacity at normal pool elevation.....N/A
- (6) Gated spillway capacity at test flood elevation.....N/A
- (7) Total spillway capacity at test flood elevation
690 cfs @ 680.8 elev.
- (8) Total Project discharge at test flood elevation
785 cfs @ 680.8 elev. (The remaining 95 cfs is carried by
the emergency overflow swale)

c. Elevation (ft. above NGVD)

- (1) Streambed at centerline of dam.....657
- (2) Test flood tailwater..... Below Spillway Crest
- (3) Upstream portal invert diversion tunnel.....N/A
- (4) Normal pool.....678
- (5) Full flood control pool.....N/A
- (6) Spillway crest.....678
- (7) Design surcharge (Original Design).....Unknown
- (8) Top of dam.....681.3 (Nominal)
- (9) Test flood design surcharge.....680.8

d. Reservoir

- (1) Length of test flood pool.....0.40 miles
- (2) Length of normal pool.....0.45 miles
- (3) Length of flood control pool.....N/A

e. Storage (acre-feet)

- (1) Normal pool.....261
- (2) Flood control pool.....N/A
- (3) Spillway crest pool.....261

- (4) Top of dam.....350
- (5) Test flood pool.....335
- f. Reservoir Surface (acres)
- (1) Normal pool.....22
- (2) Flood-control pool.....N/A
- (3) Spillway crest.....22
- (4) Test flood pool.....27
- (5) Top of dam.....28
- g. Dam Embankment
- (1) Type.....Earth embankment with corewall
- (2) Length.....Approx. 490 ft.
- (3) Height.....Approx. 24 ft.
- (4) Top Width.....12 ft.
- (5) Side slopes.....U/S, 1.5H to 1V
D/S, 1.5H to 1V (upper)
and 2H to 1V (lower)
- (6) Zoning....."Select" material U/S
- (7) Impervious Core.....Concrete corewall
- (8) Cutoff.....Two U/S cutoff trenches
and sheeting under base
of corewall
- (9) Grout curtain.....None
- h. Diversion and Regulating Tunnel.....None
- i. Spillway
- (1) Type.....Paved stone channel with
concrete weir
- (2) Length of weir.....44.5 ft.

- (3) Crest elevation.....678
(4) Gates.....None
(5) U/S Channel.....Mortared stone masonry
channel about 45 feet wide
(6) D/S Channel.....Fieldstone channel about
45 feet wide and 10 per-
cent slope

j. Regulating Outlets - The regulating outlet for this structure consists of a 24-inch C.I. drain pipe through the center of the dam. It is manually gated at a gatehouse on the upstream face of the dam. Both the upstream and downstream inverts of the pipe are about El. 657. The drain pipe discharges at a stone masonry headwall at the toe of the dam into a stone masonry channel. The channel becomes a natural channel further downstream.

SECTION 2: ENGINEERING DATA

- 2.1 Design Records - The only design record located was a print showing the proposed general configuration of the dam and appurtenances. Records on the modifications to the dam crest, spillway and downstream slope of the dam were not located.
- 2.2 Construction Records - No records of the original construction or modifications were located.
- 2.3 Operational Records - The only operational records located were reservoir water level, rainfall, and air temperature records and prior state and county inspection reports.
- 2.4 Evaluation
 - a. Availability - Documents described above are available at the Southbridge Water Supply Co., the County of Worcester, MA, and the Division of Waterways, State of Massachusetts.
 - b. Validity - Except for the length of the dam and the spillway, the general configuration of the dam and appurtenances were in good agreement with conditions observed during the site examination.
 - c. Adequacy - The available data, in combination with the visual evaluation described in the following section, is adequate for the purpose of the Phase I investigation.

SECTION 3: VISUAL INSPECTION

3.1 Findings

- a. General - The Phase I visual examination of Reservoir No. 3 Dam was conducted on 13 August 1979.

In general, the earthen embankment and spillway were observed to be in fair condition. This classification is primarily based on the observation of surficial sloughing at the downstream face, seepage at the embankment downstream toe, and debris and brush growth in the spillway downstream channel. The reservoir level at the time of the site examination was at weir crest elevation.

- b. Dam - The earth embankment is generally in fair condition. One Tow section was noted, approximately 15 feet long, at the left end of the dam embankment. There is no visual evidence of major settlement or lateral movement. Some surficial sloughing and seepage were observed at the downstream toe. No major deficiency was observed at the spillway but the spillway discharge channel contains debris and a heavy growth of weeds and brush.

The following specific items were noted:

- (1) The upstream riprap is predominantly cobbles to 1.5 ft. and boulders. The riprap cover has apparently settled at some locations. There are grass and weeds growing between some stones and an abandoned animal burrow was noted near the left abutment.
- (2) The downstream dam slope has a grass and weed cover and there is apparent sloughing in the upper part of the slope. Erosion of the downstream face near the gatehouse was noted where some hand-placed stones have been exposed and evidence of seepage was detected at the toe of the dam.
- (3) The embankment crest is mostly grass covered. However, the wheel ruts across the crest as shown in Photo 1 offer potential for local erosion if they cause channeling of runoff flow down the dam slope.
- (4) The spillway discharge channel was overgrown with weeds and brush; the channel floor was irregular and contained debris as shown in Photos 5-7. No evidence of seepage was observed in the spillway discharge channel floor or at the channel walls. However, debris in the channel floor and overgrown vegetation at the training walls obscured view.

(5) Several cracks, all of which had apparently been repaired in the past, were noted in the concrete weir at the spillway. Deterioration at the toe of the weir was also observed, and slight seepage was exiting from beneath the weir, apparently along its entire length.

- c. Appurtenant Structures - The gatehouse appeared to be adequate for its intended use. The masonry well was submerged and could not be observed. There was slight seepage from the base of the stone masonry headwall of the reservoir drain. The discharge channel was overgrown with weeds and brush and contained debris as shown in Photo 10. The walls of the channel were of dry stone masonry construction and appeared to be adequate for their intended purpose.

The emergency overflow to the left of the spillway was roughly defined and overgrown with trees and brush.

- d. Reservoir Area - Reservoir No. 3 impounds water from Hatchet Brook. Reservoir No. 3 is surrounded by moderately sloped hills which are heavily forested. The shore line of the pond is totally undeveloped, as shown in Photo 2. About 500 feet upstream of Reservoir No. 3 is the earth embankment dam of Reservoir No. 4.

Although some of the side slopes to the pond are moderately steep, there appears to be no significant potential for landslides into the pond which would create waves that might overtop the dam. No conditions were noted which could result in a sudden increase in sediment load into the pond.

- e. Downstream Channel - Reservoir No. 3 discharges to a stone masonry channel about 6 feet high by 15 feet wide with a 2.5 to 3 percent slope. It leads to a natural channel with about the same slope. There is little to no development along the banks of the channel. It crosses two roads and runs for about 6,000 feet before discharging to the Quinebaug River in the Corps of Engineers Westville Reservoir Flood Control impoundment area.

- 3.2 Evaluation - The general condition of the facility was considered fair. The observed evidence of seepage and the noted erosion features at the embankment are not considered cause for immediate concern. However, changes in the pattern or amount of seepage could indicate the development of problems with the embankment. Furthermore, the relative steepness of the downstream face increases the potential for embankment failure in the event that adverse seepage conditions were to develop.

The observation of heavy vegetation and debris in the reservoir drain and spillway discharge channels indicate the need for additional maintenance at the facility. The low area at the left end of the dam embankment and the irregular unprotected emergency overflow indicate the potential for erosion at high discharges.

SECTION 4: OPERATIONAL PROCEDURES

- 4.1 Procedures - In general, there is no formally established routine for the operation of the dam. On an informal basis, the Owner attempts to control the reservoir level by removing flashboards in the fall and replacing them in the spring.
- 4.2 Maintenance of the Dam - The grass at the dam is cut twice a year. Repairs at the facility have been performed as a result of comments on the State Inspection Reports. Maintenance for this facility is based upon need rather than on a formally established routine or procedure.
- 4.3 Maintenance of Operating Facilities - The reservoir drain is tested periodically to ensure that it remains operational.
- 4.4 Description of Any Warning System in Effect - There is no established warning system or emergency preparedness plan in effect for this structure.
- 4.5 Evaluation - Maintenance of the facility is performed on the basis of need. There is currently no formal operational procedures in effect for Reservoir No. 3. Formal operational procedures, maintenance programs, warning system and emergency preparedness plans should be established.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

- a. General - Reservoir No. 3 Dam is an earth embankment project which is fed by Hatchet Brook and forms a water supply impoundment in Southbridge, Massachusetts. The watershed is 2.37 square miles of rolling terrain with three upstream ponds and some marshy areas. The slope for the drainage area is about 2.4 percent. At spillway crest (elev. 678.0 NGVD), the reservoir storage is about 261 acre-feet, increasing to 350 acre-feet at the top of dam (elev. 681.3). The spillway, which has facilities for 12 inches of flashboards, is about 45 feet long and the overall height of the dam is about 24 feet. The length of the dam is about 490 feet. The outlet works is a 24-inch cast iron pipe located at about the center of the dam and is controlled from a gatehouse on the upstream face of the dam. Also leading from the gatehouse is a 16-inch water supply main. The dam is a high spillage, low surcharge project.
- b. Design Data - There is no hydraulic/hydrologic design data for the dam.
- c. Experience Data - The Owner of the dam, Southbridge Water Supply Co., keeps a daily record of the water level, rainfall, and air temperature for Reservoir No. 3. During high rainfall and/or snow melt periods, readings are taken more frequently. The maximum recorded water level in the reservoir occurred on 21 September 1938. There were 12 inches of flashboards in place at the time and the water level rose 23 inches above the flashboards which is approximately equivalent to a combined spillway and emergency overflow discharge of 500 cfs and a reservoir water surface elevation of 680.9. This water level was just about 5 inches below the dam top. The rainfall for the period of 18 September to 22 September was about 13.5 inches. The second highest recorded water level was 17 inches above the 12 inches of flashboards in place at the time, for an estimated total discharge of 310 cfs, and a reservoir W.S. El. of 680. The event occurred on 18 March 1936. On August 1955, the largest change in reservoir water level was recorded in a period of 10 days. The reservoir water level rose from 52.75 inches below spillway crest on 11 August 1955 to 11 inches above spillway crest on 20 August 1955, as a result of 16.6 inches of rainfall, the highest recorded rainfall for the site.

The above estimated discharges and reservoir water levels assume a spillway crest elevation of 678.0. It is also assumed that during the floods mentioned, the emergency overflow exhibited a configuration similar to that observed during the visual inspection on 14 August 1979. The owner's representative advised that there was flow through the emergency overflow during the August 1955 flood.

- d. Visual Observations - The visual inspection of the dam was made on 13 August 1979. At the time, there were no flashboards in the spillway and the reservoir water level was at spillway crest with zero discharge. The average freeboard was 3.3 feet. There were no obstructions to flow at the spillway, although the downstream channel was overgrown with brush. The outlet works were closed.
- e. Test Flood Analysis - Based on the Corps of Engineers Guidelines, the recommended test flood range for the size (small) and hazard (significant) is a 100-Year Flood to 1/2 PMF (Probably Maximum Flood). A 1/4 PMF was adopted as the test flood inflow. The test flood was calculated using the Corps of Engineers "Guidelines for Estimating Maximum Probable Discharge in Phase I Dam Safety Investigations." The watershed terrain is mostly rolling with a flat slope (about 2.5%) and a considerable amount of upstream ponded water (about 7.5% of the total drainage area) and marshland (another 2%). Based on the watershed characteristics, the 1/4 PMF inflow rate of 375 cfs per square mile was selected for the 2.37 square mile drainage area. The resulting test flood inflow is 890 cfs.

The nominal top of the dam is elevation 681.3 feet. The routed test flood outflow is 785 cfs at a stage of 680.8 and a resulting freeboard of 0.5 feet, assuming no flashboards in the spillway and the outlet works closed. With the maximum height of flashboards (about 1 foot) in the spillway, the routed test flood outflow would be 770 cfs at a stage of 681.4, again assuming the outlet works to be closed. Therefore, one foot of flashboards in the spillway with outlet works closed would cause the dam to be overtopped by 0.1 feet. Opening the 24-inch diameter C.I. outlet works pipe would increase flow from the reservoir by about 100 cfs. Spillway capacity at test flood elevation and no flashboards is 690 cfs, and would change to 550 cfs with 1 foot of flashboards in the spillway. The estimated emergency overflow capacity at test flood elevation is 90 cfs and 170 cfs, respectively, without and with flashboards in the spillway.

- f. Dam Failure Analysis - Based on the Corps of Engineers Guidelines for estimating Dam Failure Hydrographs, and assuming a failure would occur along 40 percent of the mid-height length (196 ft) at a water surface elevation of 681.3, the dam failure outflow would be 38,750 cfs. As a result of a dam failure, the chlorine building at the toe of the dam would be destroyed which would disrupt water supply to the Town of Southbridge. About 3,000 feet downstream a road would be overtopped by 9 to 10 feet and a chlorine storage building on the left bank would be damaged.

About 1,400 feet farther downstream, a 50-foot high roadway embankment would be overtopped by about 8.5 feet. A house just upstream of the roadway on the left bank would be affected. The dam failure outflow would then enter the Corps of Engineers Westville Reservoir flood control project without further hazard to structures and residences. However, the flood control area is used as a park and the dam failure outflow would thus endanger users of park. The overall potential hazard from a dam failure of Reservoir No. 3 would be "significant."

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

- a. Visual Observations - There was no visible evidence of dam instability during the site examination on 13 August 1979. However, surficial sloughing was noted along the upper part of the relatively steep downstream face and evidence of seepage was observed below the embankment toe. These conditions are not considered indicative of the need for urgent remedial action.
- b. Design and Construction Data - The plan obtained from the County of Worcester shows the basic cross-section of the dam. However, there is no data on the engineering properties of the material in the dam, nor how it was placed. In absence of this data and in view of the relatively steep downstream face, it cannot be assumed that the safety factor for static stability for the downstream face is greater than the minimum acceptable value of 1.5 recommended by the Guidelines.
- c. Operating Records - No operating records other than inspection reports by the State and County were located.
- d. Post-Construction Changes - The dam had at least one major modification after its original construction. According to available documents, the change occurred in about 1930, and consisted of the placement of a rock berm along the lower half of the downstream slope.
- e. Seismic Stability - Reservoir No. 3 Dam is located near the boundary of Seismic Zones No. 1 and 2, which are low and moderate risk areas, respectively. However, because of observed surficial instability along the upper part of the dam and because records indicate past problems with embankment sloughing, it cannot be assumed that the safety factor for the stability of the downstream slope is within conventional limits. Pertinent data needed for theoretical analysis of seismic stability are unavailable. Therefore, an assessment of the potential vulnerability of the dam to seismic events is not possible.

SECTION 7: ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

- a. Condition - Based on the results of the visual examination, the dam is considered to be in fair condition. Although some repairs are needed, no conditions which would warrant urgent remedial action were noted.
- b. Adequacy of Information - The evaluation of the dam embankment and spillway has been based primarily on the visual examination, consideration of available records and past performance, and application of engineering judgment. Generally, the information available was adequate for the purposes of the Phase I assessment. However, it is recommended that additional information relative to embankment stability be obtained as outlined in Section 7.2.
- c. Urgency - The recommendations for additional investigations and remedial measures, outlined in Sections 7.2 and 7.3, respectively, should be undertaken by the Owner within one year after receipt of this report by the Owner.
- d. Need for Additional Investigations - Additional investigations should be performed by the Owner as outlined in Section 7.2.

7.2 Recommendations

It is recommended that the Owner arrange for the following investigations to be undertaken by a registered professional engineer.

1. Investigate the long-term stability of the embankment, including evaluation of seepage and erosion conditions, and engineering properties of embankment materials. Consideration should be given to the potential for and the effects of surficial slope ravelling, seismic stability and the effects of changes in seepage conditions.
2. Investigate the effects of flood discharges at the site including erosion at the left end of the dam embankment and at the area of the emergency overflow.

The Owner should implement corrective measures as required, based on the above engineering evaluation.

7.3 Remedial Measures

a. Operation and Maintenance Procedures - The following remedial work should be undertaken by the Owner:

- (1) Vehicle traffic along the crest should be limited so that significant rutting is prevented and good grass cover is maintained.
- (2) Animal burrows on the embankment should be completely filled.
- (3) Weeds and brush should be cleared from the riprap on the upstream face and it should be restored by placing additional stones where necessary.
- (4) Remove brush and debris from the discharge channels at the spillway and reservoir drain. Also, cut and remove overhanging trees and brush from both channels.
- (5) Remove loose crack repairs and patch resulting voids and deterioration at the base of the concrete weir.
- (6) Establish a formal operational procedure and maintenance program and institute a program of annual technical inspections. The grass should be cut just prior to the technical inspections to permit detailed visual examination of the embankment. The operational procedure should include provisions for the removal of flashboards in anticipation of high rainfall or high discharges.
- (7) Develop a formal emergency procedures plan and warning system in cooperation with local officials in downstream communities.

7.4 Alternatives - There are no practical alternatives recommended.

VISUAL INSPECTION PARTY ORGANIZATION

NATIONAL DAM INSPECTION PROGRAM

DAM: Reservoir No. 3

DATE: 13 August 1979

TIME: 1:00 PM

WEATHER: Clear Blue Skies - Temperature in 60's

WATER SURFACE ELEVATION UPSTREAM: Water surface at Spillway Crest
Elevation.

STREAM FLOW: None

INSPECTION PARTY:

1. Joseph E. Downing - CDM - Hydraulic/Hydrology
2. Francis E. Luttazi - CDM - Structural/Operations
3. John Critchfield - Haley & Aldrich
4. Douglas Gifford - Haley & Aldrich
5. _____

PROJECT FEATURE	INSPECTED BY	REMARKS
1. _____	_____	_____
2. _____	_____	_____
3. _____	_____	_____
4. _____	_____	_____

PRESENT DURING INSPECTION:

1. _____
2. _____
3. _____

APPENDIX A-1

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Reservoir No. 3

DATE: 13 August 1979

EMBANKMENT: DAM

BY: JWC & DGG

CHECK LIST	CONDITION
1. Upstream Slope a. Vegetation b. Sloughing or Erosion c. Rock Slope Protection - Riprap Failures d. Animal Burrows 2. Crest a. Vegetation b. Sloughing or Erosion c. Surface cracks d. Movement or Settlement 3. Downstream Slope a. Vegetation b. Sloughing or Erosion c. Surface cracks d. Animal Burrows e. Movement or Cracking near toe f. Unusual Embankment or Downstream Seepage g. Piping or Boils h. Foundation Drainage Features i. Toe Drains 4. General a. Lateral Movement b. Vertical Alignment c. Horizontal Alignment d. Condition at Abutments and at Structures e. Indications of Movement of Structural Items f. Trespassing g. Instrumentation Systems	1. a. Few weeds in riprap. b. None observed. c. Riprap consists of cobble sized stones. Some pieces slightly weathered. d. One abandoned burrow noted near left end. 2. a. Grass and weeds. b. Some rusting. c. None observed. d. None apparent. 3. a. Grass, weeds and ferns. b. Surficial sloughing of sod all along upper portion of slope. c. None observed. d. Two abandoned burrows noted along berm. e. None observed. f. No evidence of seepage observed on D/S slope. Wet area below toe, right of chlor. sta. had some evidence of flow but no noticeable soil movement. g. None observed. i. None known 4. a. None apparent b. Good. c. Good. d. Good. e. None observed. f. Restricted by locked gate. g. None known.

**VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM**

DAM: Reservoir No. 3

DATE: 13 August 1979

SPILLWAY: _____

BY: F.E.L.

CHECK LIST	CONDITION
1. Approach Channel a. General Condition b. Obstructions c. Log Boom etc.	1. Note: Spillway fronts directly on reservoir. a. Good. b. None observed. c. None observed.
2. Weir a. Flashboards b. Weir Elev. Control (Gate) c. Vegetation d. Seepage or Efflorescence e. Rust or Stains f. Cracks g. Condition of Joints h. Spalls, Voids Or Erosion i. Visible Reinforcement j. General Struct. Condition	2. a. None observed. However, ten metal flashboard supports ("pigs") were observed in place providing for nine bays of flashboarding. b. See "Outlet Works." c. None observed. d. Seepage from beneath concrete weir. Minor seepage from cracks noted in 2f. e. Some rusting at flashboard pigs. f. Several cracks were observed in concrete weir, all of which appeared to have been repaired in the past. g. N/A. h. Deterioration at toe of concrete weir observed. i. None observed. j. Good.
3. Discharge Channel a. Apron b. Stilling Basin c. Channel Floor d. Vegetation e. Seepage f. Obstructions g. General Struct. Condition	3. a. Approx. six feet of set stone in fair condition extends beyond granite sill. b. None. c. Contains debris. d. Heavy growth of brush and weeds at floor and channel walls. e. None observed. However, vegetation obscured view. f. See 3c and 3d. g. Fair.
4. Walls a. Wall Location _____ (1) Vegetation (2) Seepage or Efflorescence (3) Rust or Stains (4) Cracks (5) Condition of Joints (6) Spalls, Voids or Erosion (7) Visible Reinforcement (8) General Struct. Condition	4. a. Right and Left Stone Masonry Training Walls. 1. Heavy overhanging brush growth. 2. None observed. 3. None observed. 4. None observed. 5. Good. 6. Minor voids at joints located at

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Reservoir No. 3

DATE: 13 August 1979

SPILLWAY: (Continued)

BY: F.E.L.

CHECK LIST

CONDITION

1. Approach Channel
 - a. General Condition
 - b. Obstructions
 - c. Log Boom etc.
2. Weir
 - a. Flashboards
 - b. Weir Elev. Control (Gate)
 - c. Vegetation
 - d. Seepage or Efflorescence
 - e. Rust or Stains
 - f. Cracks
 - g. Condition of Joints
 - h. Spalls, Voids Or Erosion
 - i. Visible Reinforcement
 - j. General Struct. Condition
3. Discharge Channel
 - a. Apron
 - b. Stilling Basin
 - c. Channel Floor
 - d. Vegetation
 - e. Seepage
 - f. Obstructions
 - g. General Struct. Condition
4. Walls
 - a. Wall Location _____
 - (1) Vegetation
 - (2) Seepage or Efflorescence
 - (3) Rust or Stains
 - (4) Cracks
 - (5) Condition of Joints
 - (6) Spalls, Voids or Erosion
 - (7) Visible Reinforcement
 - (8) General Struct. Condition

- right training wall.
7. None observed.
 8. Good

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

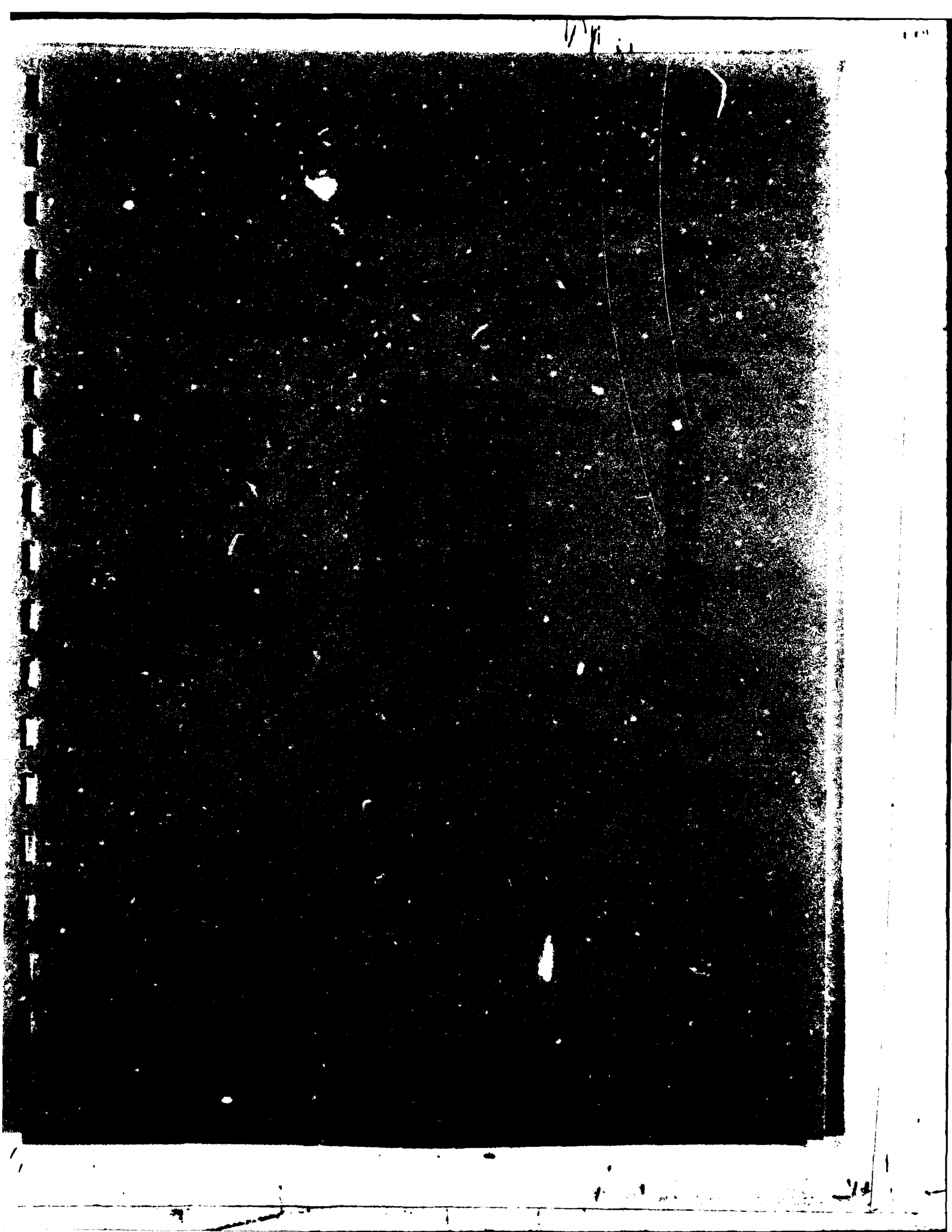
DAM: Reservoir No. 3

DATE 13 August 1979

OUTLET WORKS:

BY: F.E.L.

CHECK LIST	CONDITION
1. Inlet <ul style="list-style-type: none"> a. Obstructions b. Channel c. Structure d. Screens e. Stop Logs f. Gates 	1. <ul style="list-style-type: none"> a. None observed. b. Inlet draws directly from reservoir. c. See "Control Facility". d. None observed. Submerged. e. None observed. f. Submerged.
2. Control Facility <ul style="list-style-type: none"> a. Structure b. Screens c. Stop Logs d. Gates e. Conduit f. Seepage or Leaks 	2. <ul style="list-style-type: none"> a. Wooden gatehouse in good condition, houses rubble masonry gate shaft and gate operators. Gatehouse sits out into reservoir and concrete retaining walls confining earth fill landing leading to gatehouse, were observed to be in good condition. b. Submerged. c. N/A. d. Submerged. e. Submerged. f. None observed. Submerged.
3. Outlet <ul style="list-style-type: none"> a. Structure b. Erosion or Cavitation c. Obstructions d. Seepage or Leaks 	<ul style="list-style-type: none"> b. Submerged. c. N/A. d. Submerged. e. Submerged. f. None observed. Submerged.
4. Mechanical and Electrical <ul style="list-style-type: none"> a. Crane Hoist b. Hydraulic System c. Service Power d. Emergency Power e. Lighting f. Lightning Protection 	3. <ul style="list-style-type: none"> a. Stone masonry headwall at toe of downstream embankment slope in generally good condition. b. None observed. c. Brush growth at Reservoir drain channel floor. Gravel build up to left of outlet conduit at headwall, apparently due to erosion of gravel road located directly above. d. Some seepage through conduit.
5. Other	4. <ul style="list-style-type: none"> a. Provision for a chain fall at gatehouse. b. None known. c. Rack and pinion gate manually operated. Turnstile gate manually operated. d. None. e. None apparent. f. None observed.



LIST OF DOCUMENTS

RESERVOIR NO. 3

ALL AVAILABLE DOCUMENTS ARE INCLUDED IN APPENDIX B.

DESCRIPTION OF DAM

DISTRICT 3

Submitted by W. H. HARRIS, Jr. Dam No. 3-14-278-16

Date 2-6-73 City/Town SCOTTSDALE

Name of Dam #3 HARRISVILLE

1. Location: Topo Sheet No. 18D

Provide 8 1/2" x 11" in clear copy of topo map with location of Dam clearly indicated.

2. Year built: 1894 Year/s of subsequent repairs 1930

3. Purpose of Dam: Water Supply ☒ Recreational ☐

Irrigation ☐ Other ☐

4. Drainage Area: 2.35 sq. mi. ☐ acres

5. Normal Ponding Area: 22 acres; Ave. depth ☐

Impoundment: 85,000,000 gals.; ☐ acre ft.

6. No. and type of dwellings located adjacent to pond or reservoir

1 i.e. summer homes, etc. GATE HOUSE

7. Dimensions of Dam: Length 320' Max. Height 22'

Slopes: Upstream Face 3:1

Downstream Face 1:1

Width across top 10'

8. Classification of Dam by Material:

Earth ☒ Conc. Masonry ☒ Stone Masonry ☒

Timber ☐ Rockfill ☐ Other ☐

9. A. Description of present land usage downstream of dam:

100 % rural; ☐ % urban.

B. Is there a storage area or flood plain downstream of dam which could accomodate the impoundment in the event of a complete dam failure? yes ☒ no ☐

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APPENDIX B-2

DAM NO. 3-14-278-16

10. Risk to life and property in event of complete failure.

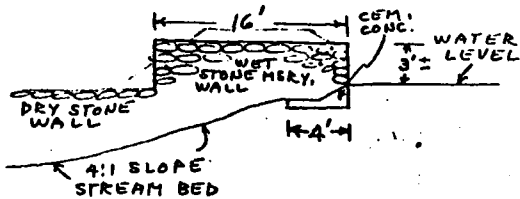
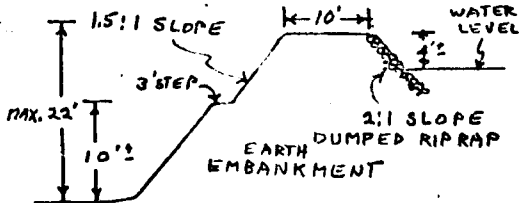
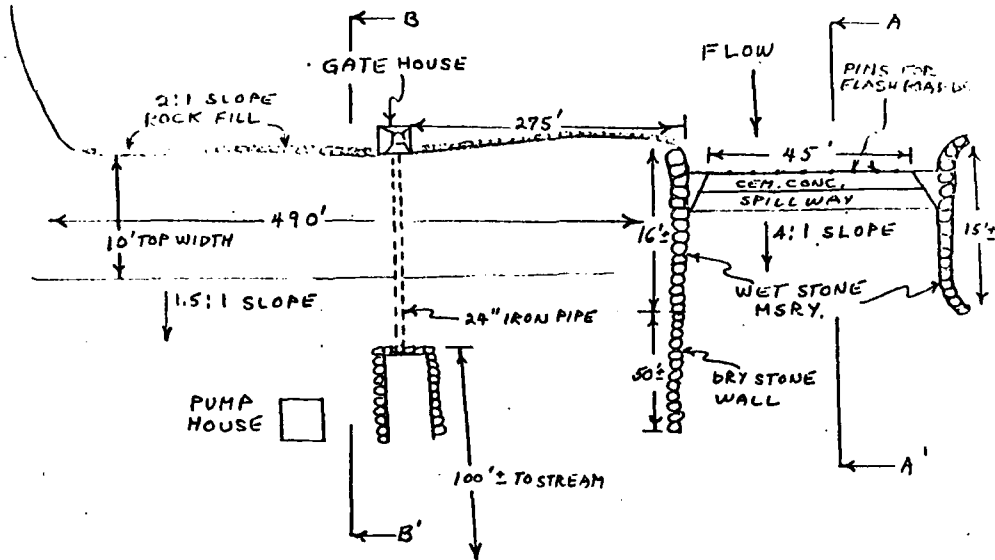
No. of people NONE.
No. of homes NONE.
No. of Businesses NONE.
No. of industries NONE. Type _____
No. of utilities NONE. Type _____
Railroads NONE.
Other dams NONE.
Other NONE.

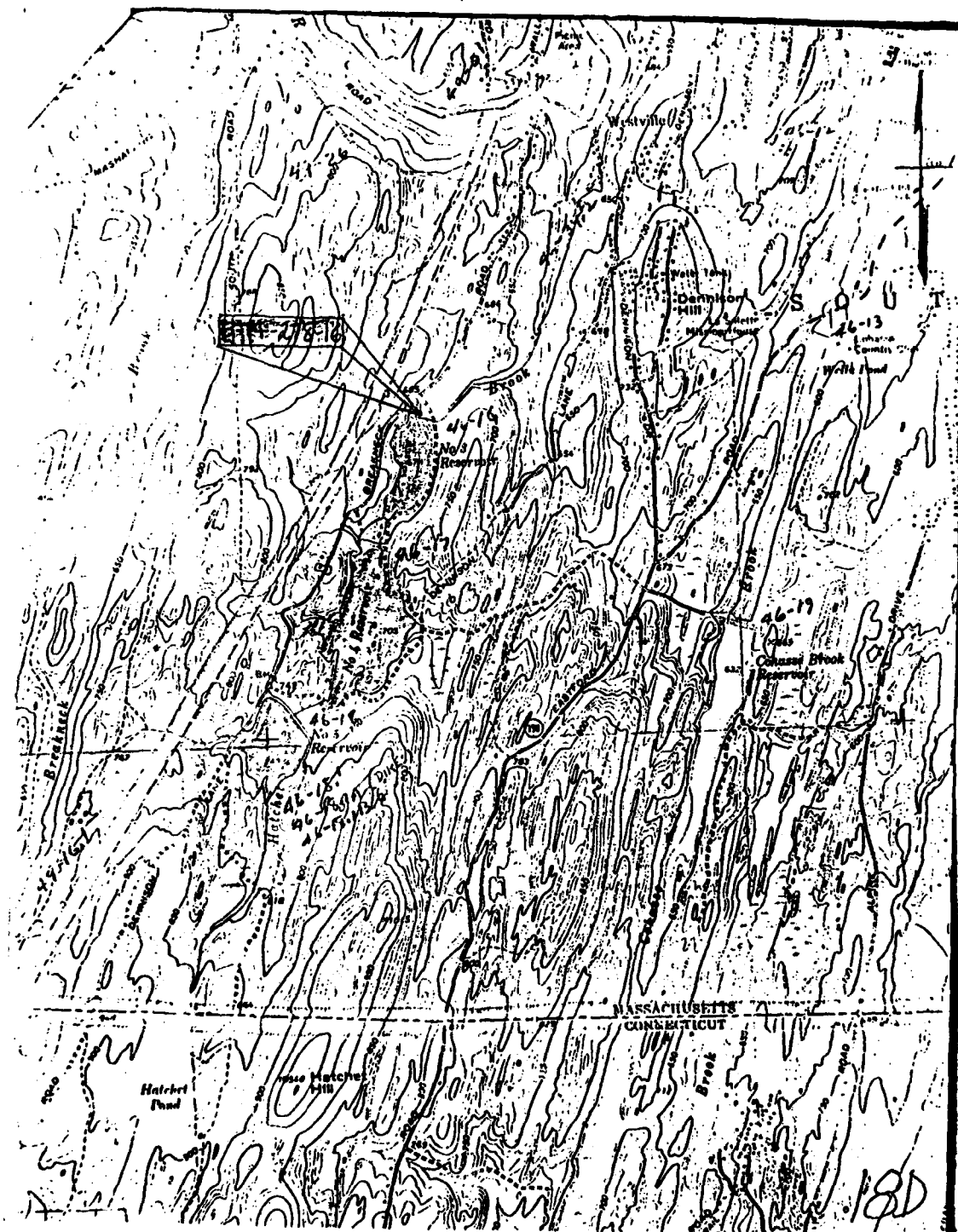
11. Attach Sketch of dam to this form showing section and plan on 8 1/2" x 11" sheet.

12. How to Locate: FROM INTERSECTION OF SOUTH ST. 4 BREAKNECK
RD. 0.8 MILES ON BREAKNECK RD. TO GATE 4 GRAVEL
RD. ON LT. 500' ± ON GRAVEL RD. TO DAM.

DAM # 3-14-278-1
SOUTH BRIDGE
FEB 6, 1973
RESERVOIR No. 3 DAM

POND AREA





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TOWN OR CITY *Southbridge* DECREE NO.

LOCATION *Woodstock Road*

DESCRIPTION OF DAM *El. 100'*

Type *Earth - Masonry Abts - stone apron*

Length *650'*

Height *20'*

Thickness top *abt 10'*

" bottom *12'*

Downstream Slope *1 1/2:1*

Upstream *1 1/2:1*

Length of Spillway *El. crest: 96' Depth: 4.0' 50'*

Size of Gates *Stream 1-16" Pipe 1-24" Pipe*

Location of Gates *Gate House center of dam*

Flashboards used *None*

Width Flashboards or Gates *El. 97 if used*

Dam designed by *A. C. Moore*

" constructed by *1893*

Year constructed *1894*

GENERAL REMARKS

Vol 23 - P. 213. Sept. 12, 1893.
Divined by Southbridge Water Supply Co
Inspected Jan. 6, 1925. L. O. Marden
Nov. 26, 1929. " " Mr. Abbott
April 27, 1932. " " Mr. Abbott
Oct. 6, 1938. E. S. Greer
Dec. 12, 1940. W. O. Lindquist
Aug. 24, 1960. L. O. M.

PLAN NO.

DAM NO. *46-16*

C. C. DOCKET NO.

DESCRIPTION OF RESERVOIR & WATERSHED

Name of Main Stream *#3 Hatchet Brook*

" " any other Streams

Length of Watershed

Width " "

Is Watershed Cultivated

Percent in Forests

Steepness of Slope

Kind of Soil *Rocky*

No. of Acres in Watershed *2.18 Sq. M.*

" " " Reservoir *22*

Length of Reservoir

Width " "

Max Flow Cu. Ft. per Sec.

Head of Flashboards - Low Water

" " " High " "

GENERAL REMARKS

Plan traced by L. C. Farrar - March 1940.
Tracing checked - L. O. M. 1945
Inspected: 10-29-43. L. O. M. G. H. Abbott
12-11-47
Aug. 24, 1960. " " " "

Inspected: Aug. 24, 1960 - L. O. M. C. Spruogel - Teton

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INSPECTION REPORT - DAMS AND RESERVOIRS

1. Location: City/Town SOUTHBRIDGE Dam No. 3-14-278-16
 Name of Dam #2 RESERVOIR Inspected by R. MICHAEL P. MARK
 Date of Inspection 2-6-73

2. Owner/s: per: Assessors _____ Prev. Inspection _____
 Reg. of Deeds _____ Pers. Contact ✓

1. SOUTHBRIDGE WATER SUPPLY CO. 70 FASTER ST. SOUTHBRIDGE, MA. 01550
 Name _____ St. & No. _____ City/Town State Tel. No. _____

2. _____
 Name _____ St. & No. _____ City/Town State Tel. No. _____

3. _____
 Name _____ St. & No. _____ City/Town State Tel. No. _____

3. Caretaker (if any) e.g. superintendent, plant manager, appointed by absentee owner, appointed by multi owners.

Name: _____ St. & No.: _____
 City/Town: _____ State: _____ Tel. No.: _____

4. No. of Pictures taken NONE

5. Degree of Hazard: (if dam should fail completely)*

1. Minor ✓ 2. Moderate _____
 3. Severe _____ 4. Disastrous _____

* This rating may change as land use changes (future development)

6. Outlet Control: Automatic _____ Manual ✓
 Operative ✓ yes; _____ No.

Comments:

7. Upstream Face of Dam: Conditions:

1. Good ✓ 2. Minor Repairs _____
 3. Major Repairs _____ 4. Urgent Repairs _____

Comments:

8. Downstream Face of Dam:

Condition: 1. Good ✓ 2. Minor Repairs _____
3. Major Repairs _____ 4. Urgent Repairs _____

Comments:

9. Emergency Spillway: None

Condition: 1. Good _____ 2. Minor Repairs _____
3. Major Repairs _____ 4. Urgent Repairs _____

Comments:

10. Water Level at time of inspection: 0.1 ft. above ✓ below _____
top of dam _____ principal spillway ✓
other _____

11. Summary of Deficiencies Noted:

Growth (Trees and Brush) on Embankment NONE
Animal Burrows and Washouts NONE
Damage to slopes or top of dam NONE
Cracked or Damaged Masonry NONE
Evidence of Seepage NONE
Evidence of Piping NONE
Erosion NONE
Leaks NONE
Trash and/or debris impeding flow NONE
Clogged or blocked spillway NO
Other NONE

12. Remarks & Recommendations: (Fully Explain)

THE DAM & THE ADJACENT GROUND'S ARE EXCEPTIONALLY
WELL MAINTAINED BY THE PRIVATE WATER COMPANY'S WORK
FORCE.

13. Overall Conditions:

1. Safe ☒
2. Minor repairs needed _____
3. Conditionally safe - major repairs needed _____
4. Unsafe _____
5. Reservoir impoundment no longer exists (explain)
Recommend removal from inspection list _____

TOWN Spillbridge DAM NO. 4512 Spillbridge
LOCATION _____ STREAM _____

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

D A M I N S P E C T I O N R E P O R T

Owned by _____ Place _____ Use _____
Inspected by Daynold Date _____
Type of Dam _____ Condition _____

S P I L L W A Y

Flashboards in Place _____ Recent Repairs _____
Condition Water level 45 ins below crest
Repairs Needed no flashboards, gates closed

E M B A N K M E N T

Recent Repairs _____
Condition _____
Repairs Needed _____

G A T E S

Recent Repairs _____
Condition _____
Repairs Needed _____

L E A K S

How Serious _____
DATE 10/1/69 County Engineer _____

TOWN Southbridge DAM NO. 46-16
LOCATION Brentnack Rd STREAM Hatchet Brook
- below dam 46-17
WORCESTER COUNTY ENGINEERING DEPARTMENT "83 Reservoir"
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Owned by Southbridge Water Supply Co Place Southbridge Use Water supply
Inspected by Wm. Spiegel Date Apr. 27, 1964
Type of Dam Earth, stone & concrete Condition Good

SPILLWAY

Flashboards in Place 12" of boards Recent Repairs _____
Condition The boards will be removed about June 1st & additional
Repairs Needed over flow spillway will be constructed in 1964, north of
at the present spillway.

EMBANKMENT

Recent Repairs Many years ago the downstream & H&L slope was graded
Condition - at the bottom 1/2 of this slope was filled with stone - there
Repairs Needed 1 - graded and seeded - this lower 1/2 is now 1 1/2 to 1 slope
- the upstream slope is 1 1/2 to 1 with heavy stone riprap.

GATES

Recent Repairs 16" pipe cut let - screw down gate & with hand operated
Condition wharf - also on 16" flow off pipe with a under ground
Repairs Needed gate valve is situated at the foot of the
downstream slope.

LEAKS

Serious in leaks

CERT. ENGINEER

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APPENDIX B-11

TOWN Southbridge DAM NO. 4676

LOCATION Rte #3 STREAM Hatchet Pond

Woodstock Rd

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Owned by Southbridge W.S.G. Place Southbridge Use _____

Inspected by Spickard, J. W. O. L. L. N. Date 3-28-62

Type of Dam _____ Condition Good

SPILLWAY

Flashboards in Place None Recent Repairs _____

Condition Good

Repairs Needed None

Note: by W.S.G. (Spillway too small) 1955 Flood - water level was about 6" from top of embankment. - owners to construct natural overflow of 50' to 75' wide, fully

EMBANKMENT of present spillway with crest about 12" above present crest.

Recent Repairs None

Condition Good

Repairs Needed None

GATES

Recent Repairs None

Condition Good

Repairs Needed None

LEAKS

How Serious Serious, see page

DATE: 3-28-62 L.D.M. County Engineer

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TOWN Southbridge DAM NO. 46-16 - 43
LOCATION Breakneck Rd STREAM _____

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Owned by Southbridge Water Supply Co Place _____ Use _____
Inspected by L. M. C. Spielvogel - Peden Date Aug. 24, 1960
Type of Dam _____ Condition _____

SPILLWAY

Flashboards in Place _____ Recent Repairs _____
Condition Good
Repairs Needed _____

EMBANKMENT

Recent Repairs _____
Condition Good
Repairs Needed _____

GATES

Recent Repairs _____
Condition Good
Repairs Needed _____

LEAKS

How Serious small leak - may be spring

DATE: Aug. 24, 1960 L. M. C. Spielvogel County Engineer

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TOWN Southbridge

DAM NO. 6-16

LOCATION _____

STREAM _____

WORCESTER COUNTY ENGINEERING DEPARTMENT

WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

OWNED BY Southbridge

PLACE _____

USE Reservoir

INSPECTED BY LH Spofford

DATE 4/2/54

TYPE OF DAM _____

CONDITION _____

SPILLWAY

FLASHBOARDS IN PLACE 16"

RECENT REPAIRS None

CONDITION Good

REPAIRS NEEDED _____

EMBANKMENT

RECENT REPAIRS None

CONDITION Good

REPAIRS NEEDED _____

GATES Drawn off in gate house

RECENT REPAIRS Mgr of Water Dept not at dam

CONDITION OK

REPAIRS NEEDED _____

LEAKS

HOW SERIOUS _____

DATE _____

CITY ENGINEER

TOWN Southbridge
LOCATION No. 3 Res.

DAM NO. 6-16
STREAM Hatchet E

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

OWNED BY Southbridge Water Dept. PLACE Southbridge USE water supply
INSPECTED BY Abbott-Marden DATE Dec. 11, 1947
TYPE OF DAM earth emb. stone spillway CONDITION good

SPILLWAY

FLASHBOARDS IN PLACE permanent concrete RECENT REPAIRS none
CONDITION see below
REPAIRS NEEDED should remove permanent concrete board and replace with
flashboard- clean up spillway channel

EMBANKMENT

RECENT REPAIRS none
CONDITION _____
REPAIRS NEEDED check seepage through embankment.

GATES

RECENT REPAIRS none
CONDITION appear OK
REPAIRS NEEDED none

LEAKS

HOW SERIOUS seepage through embankment-not dangerous
DATE Feb. 17, 1948

L. O. Marden
COUNTY ENGINEER

COUNTY OF WORCESTER MASSACHUSETTS
COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by Lo M. C. H. Allen Date 10-29-53 Dam No. 46-16

Town Southbridge Location Rd 93

Owner Southbridge Water Supply Co. Use

Material and Type

Dam Designed by Constructed by Year

SPILLWAY

El. top Abutment El. Crest El. Apron El. Streambed

Width top Abutment Width top Crest Width bottom Spillway

Width Flashboards carried Kind Flashboards

El. Flowline Cleanout Pipe Size and Kind Cleanout Pipe

Kind of Foundation under Spillway

Condition fair - can clean channel this fall
Had at abutment end

EMBANKMENT

El. Top El. Natural Ground Width Top

Width of Bottom Upstream Slope Downstream Slope

Kind of Corewall Riprap

Material in Embankment Foundation

Condition good condition - some seepage

GATES

Location

Size Kind El. Flowline

Condition

WHEEL Kind Size Rated H. P.

Location Ave. Head

Evidence of Leaks in Structure

Recent Repairs and Date

Topography of Country below Dam

Nature of Buildings and Roads below Dam

Number Acres in Pond Drainage Area in Square Miles

Discharge in Second Feet per Square Mile

Unated Storage Million Cubic Feet 85,000,000
9015

WORCESTER COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs

Inspected by L.D. Marden Date 12-8-41 Dam No. 46-16

Town Southbridge Location _____

Owner Southbridge Water Co. Use _____

SPILLWAY
El. top abutment _____ El. Crest _____ El. Apron _____ El. St. Bed _____

Width top Abut. _____ Width top Crest _____ Width bottom Sp. way _____

Width flashboards _____ Kind Flashboards _____

El. Flowline Cleanout Pipe _____ Size and Kind Pipe _____

Kind of foundation under Spillway _____

Condition Cut brush from pavement - remove & piece of concrete across spillway and place pin boards.

EMBANKMENT

El. Top _____ El. Natural Ground _____ Width Top _____

Width of Bottom _____ Upstream Slope _____ Downstream Slope _____

Kind of Corewall _____ Riprap _____

Material in Embankment _____ Foundation _____

Condition Appears O.K. Brush has been cut. Some show of seepage toe near gate house.

GATES _____ Location _____

Size _____ Kind _____ El. Flowline _____

Condition _____

Evidence of leaks in structure _____

Recent Repairs and Date _____

Number Acres in Pond _____ Drainage Area in Sq. Miles _____

Discharge in Second Feet per Square Mile _____

Estimated Storage Million Cubic Feet _____

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**COUNTY OF WORCESTER MASSACHUSETTS
COUNTY ENGINEER**

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by W.D. Lindquist Date Dec. 12, 1940 Dam No. 46-16

Town SOUTHERDIE Location Reservoir #3

Owner _____ Use _____

Material and Type _____

Dam Designed by _____ Constructed by _____ Year _____

SPILLWAY

El. top Abutment _____ El. Crest _____ El. Apron _____ El. Streambed _____

Width top Abutment _____ Width top Crest _____ Width bottom Spillway _____

Width Flashboards carried _____ Kind Flashboards _____

El. Flowline Cleanout Pipe _____ Size and Kind Cleanout Pipe _____

Kind of Foundation under Spillway _____

Condition Pond Full. No flashboards.

New bridge built 1929 below spillway.

EMBANKMENT

El. Top _____ El. Natural Ground _____ Width Top _____

Width of Bottom _____ Upstream Slope _____ Downstream Slope _____

Kind of Corewall _____ Riprap _____

Material in Embankment _____ Foundation _____

Condition OK

GATES

Size _____ Kind _____ Location _____ El. Flowline _____

Condition Closed

WHEEL _____ Kind _____ Size _____ Rated H. P. _____

Location _____ Ave. Head _____

Evidence of Leaks in Structure _____

Recent Repairs and Date _____

Topography of Country below Dam _____

Nature of Buildings and Roads below Dam _____

Number Acres in Pond _____ Drainage Area in Square Miles _____

Discharge in Second Feet per Square Mile _____

Estimated Storage Million Cubic Feet _____

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COUNTY OF WORCESTER MASSACHUSETTS
COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by E. B. Brown Date Oct 6 1938 Dam No. 46-17

Town Southbridge Location Hatchet Brook No 3
Owner Southbridge Water Supply Co Use Town Water
Material and Type Earth

Dam Designed by _____ Constructed by _____ Year _____

SPILLWAY 50 FT LONG

El. top Abutment _____ El. Crest _____ El. Apron _____ El. Streambed _____

Width top Abutment _____ Width top Crest _____ Width bottom Spillway _____

Width Flashboards carried 2" Kind Flashboards Weed

El. Flowline Cleanout Pipe _____ Size and Kind Cleanout Pipe _____

Kind of Foundation under Spillway Rocks

Condition OK

NOTE: - CREST BOARDS (2") GONE - $\frac{1}{2}$ INCH WATER GOING OVER CONCRETE

EMBANKMENT

El. Top 2' 6" Above Crest El. Natural Ground _____ Width Top _____

Width of Bottom 25 FT TO 60 FT Upstream Slope 5 FT TO W. L. Downstream Slope _____

Kind of Corewall NONE Riprap YES

Material in Embankment GRAVEL Foundation _____

Condition Evidence of Water going over Top of Embankments in several places

GATES OK Location _____

Size _____ Kind _____ El. Flowline _____

Condition _____

WHEEL _____ Kind _____ Size _____ Rated H. P. _____

Location _____ Ave. Head _____

Evidence of Leaks in Structure _____

Recent Repairs and Date _____

Topography of Country below Dam Woods & Brush

Nature of Buildings and Roads below Dam Meter House (Brick) at foot of embankment NE of Gate House OK after flood

Number Acres in Pond _____ Drainage Area in Square Miles _____

Discharge in Second Foot per Square Mile _____

Estimated Storage Million Cubic Feet _____

HIGH WATER: - Barely over Embankment

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by L.O. Marden - Mr. Abbott Date April 27, 1935 Dam No. 66-11

Town Southbridge Location Southbridge No.

Owner Southbridge Water Supply Co. Use

Material and Type

Dam Designed by Constructed by Year

SPILLWAY—Length Feet. Depth Feet

El. top Abutment El. Crest El. Apron El. Streambed

Width top Abutment Width top Crest Width bottom Spillway

Width Flashboards carried Kind Flashboards

El. Flowline Cleanout Pipe Size and Kind Cleanout Pipe

Kind of Foundation under Spillway

Condition good

EMBANKMENT—Length overall Feet

El. Top El. Natural Ground Width Top

Width of Bottom Upstream Slope Downstream Slope

Kind of Corewall Riprap

Material in Embankment Foundation

Condition have widened downstream slope with rock and gravel, as agreed upon consulting work on job by Metcalf & Eddy-Boston.

GATES Location

Size Kind El. Flowline

Condition good

WHEEL Kind Size Rated H. P.

Location Ave. Head

Evidence of Leaks in Structure none to any amount

Recent Repairs and Date

Topography of Country below Dam

Nature of Buildings and Roads below Dam

Number of Acres in Pond Drainage Area in Square Miles

Discharge in Second Feet per Square Mile

Estimated Storage Million Cubic Feet

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APPENDIX B-20

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

General:

Inspected by L. O. Jordan Date Nov. 26, 1929 Dam No. 46-11

Town Southbridge Location Pond No. 3 South of center

Owner Southbridge Water Co. Use water supply.

Material and Type

Dam Designed by Constructed by Year

SPILLWAY

El. top Abutment El. Crest El. Apron El. Streambed

Width top Abutment Width top Crest Width bottom Spillway

Width Flashboards carried Kind Flashboards

El. Flowline Cleanout Pipe Size and Kind Cleanout Pipe

Kind of Foundation under Spillway

Condition flashboards on - brings water so high, that it is stepping thru the embankment over corewall - Saw Mr. Abbott manager - says he will remove boards and believes that leak will stop - Mr. Sherman of Vetsail & Son

EMBANKMENT also examined dam recently and recommends downstream stonefill

El. Top El. Natural Ground Width Top

Width of Bottom Upstream Slope Downstream Slope

Kind of Corewall Riprap

Material in Embankment Foundation

Condition

GATES

Location

Size Kind El. Flowline

Condition

WHEEL

Kind Size Rated H. P.

Location Ave. Head

Evidence of Leaks in Structure leak in embankment near center dam as described above - water coming thru dam clear - fair sized stream.

Recent Repairs and Date

Topography of Country below Dam

Nature of Buildings and Roads below Dam

Number Acres in Pond

Drainage Area in Square Miles

Discharge in Second Feet per Square Mile

Estimated Storage in Cubic Feet

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**COUNTY OF WORCESTER MASSACHUSETTS
COUNTY ENGINEER**

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by L.O. Kardon Date Jan. 6, 1926 Dam No. 16-11

Town Southbridge Location Woodstock Rd. - #3 Hatchet Brook.

Owner Southbridge Water Supply Co. Use water supply.

Material and Type earth-masonry abts. to spillway-stone apron-

Dam Designed by _____ Constructed by _____ Year _____

SPILLWAY -length 45' more or less.

El. top Abutment 100. El. Crest 98. El. Apron _____ El. Streambed 76.

Width top Abutment 10 Width top Crest _____ Width bottom Spillway _____

Width Flashboards carried 27' can use Kind Flashboards none present.

El. Flowline Cleanout Pipe 16" main line Size and Kind Cleanout Pipe 20" blowoff

Kind of Foundation under Spillway rocky soil

Condition good

EMBANKMENT-length 650' more or less.

El. Top 100. El. Natural Ground _____ Width Top 10.

Width of Bottom _____ Upstream Slope 1 1/2:1 Downstream Slope 1 1/2:1

Kind of Coverall _____ Riprap yes

Material in Embankment earth Foundation rocky soil.

Condition good

GATES _____ Location C.L. Dam

Size _____ Kind _____ El. Flowline _____

Condition good

WHEEL _____ Kind _____ Size _____ Rated H.P. _____

Location _____ Ave. Head _____

Evidence of Leaks in Structure none

Recent Repair and Date none

Topography of Country below Dam wooded valley.

Nature of Buildings and Roads below Dam _____

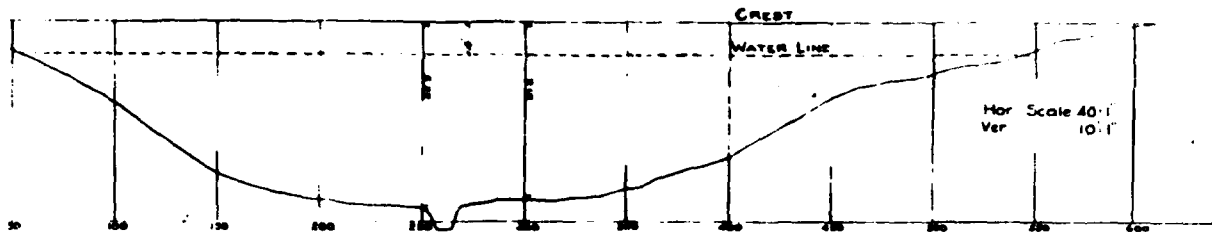
Number Acres in Pond _____ Drainage Area in Square Miles _____

Discharge in Second Foot per Square Mile _____

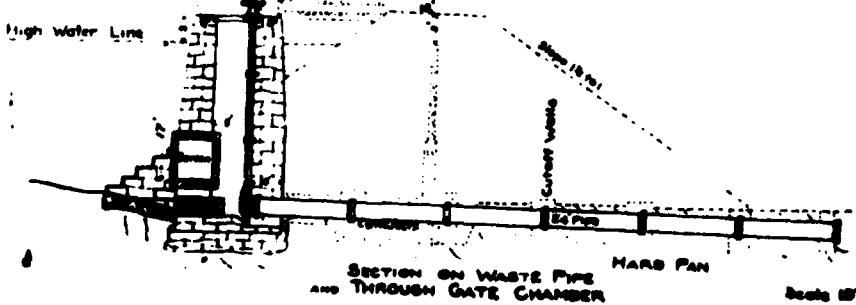
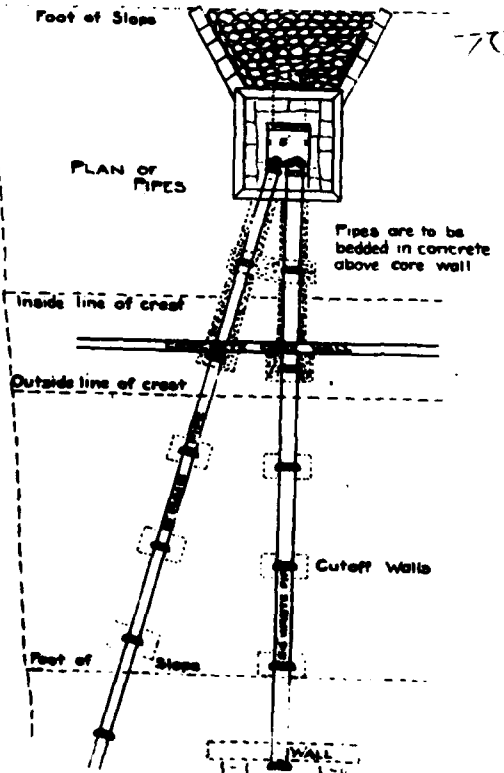
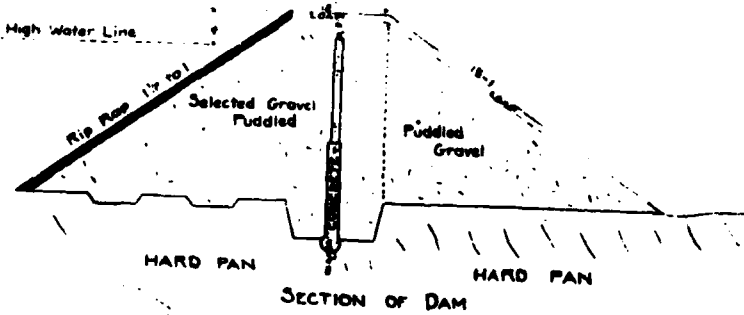
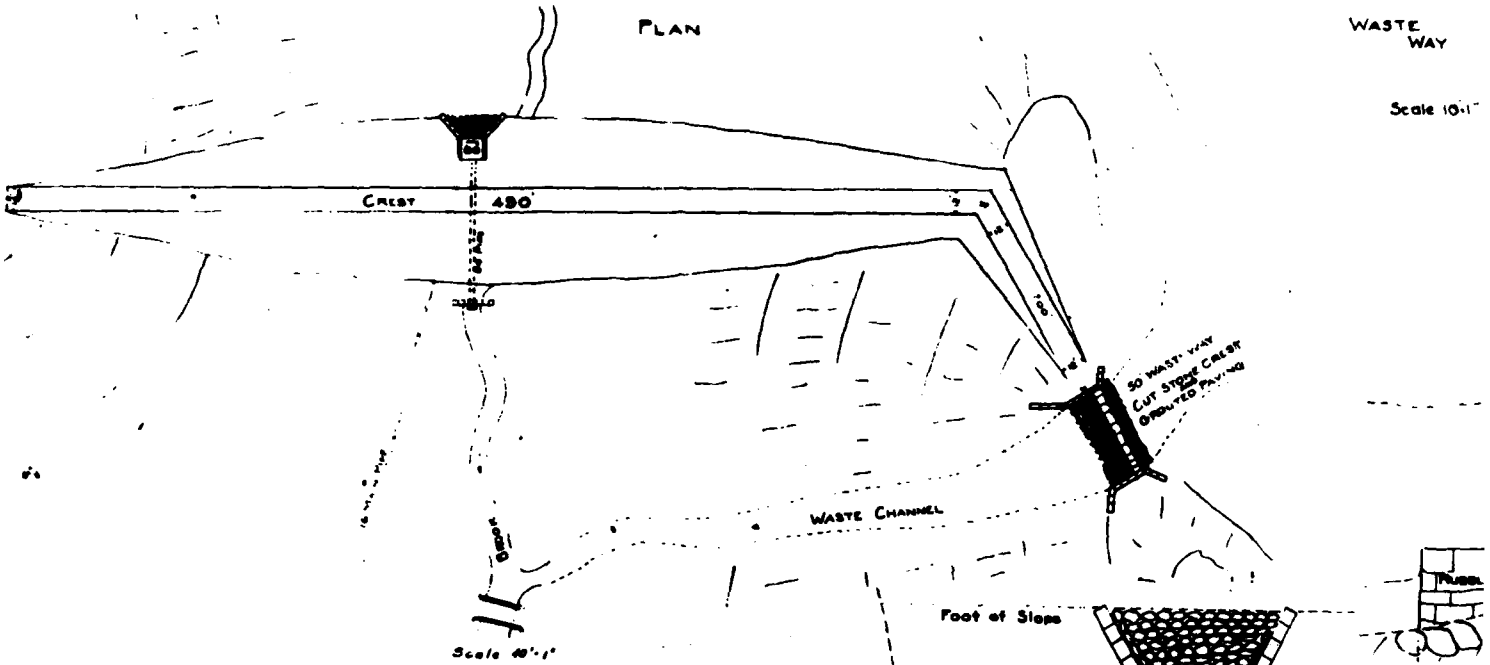
Estimated Storage Million Cubic Feet _____

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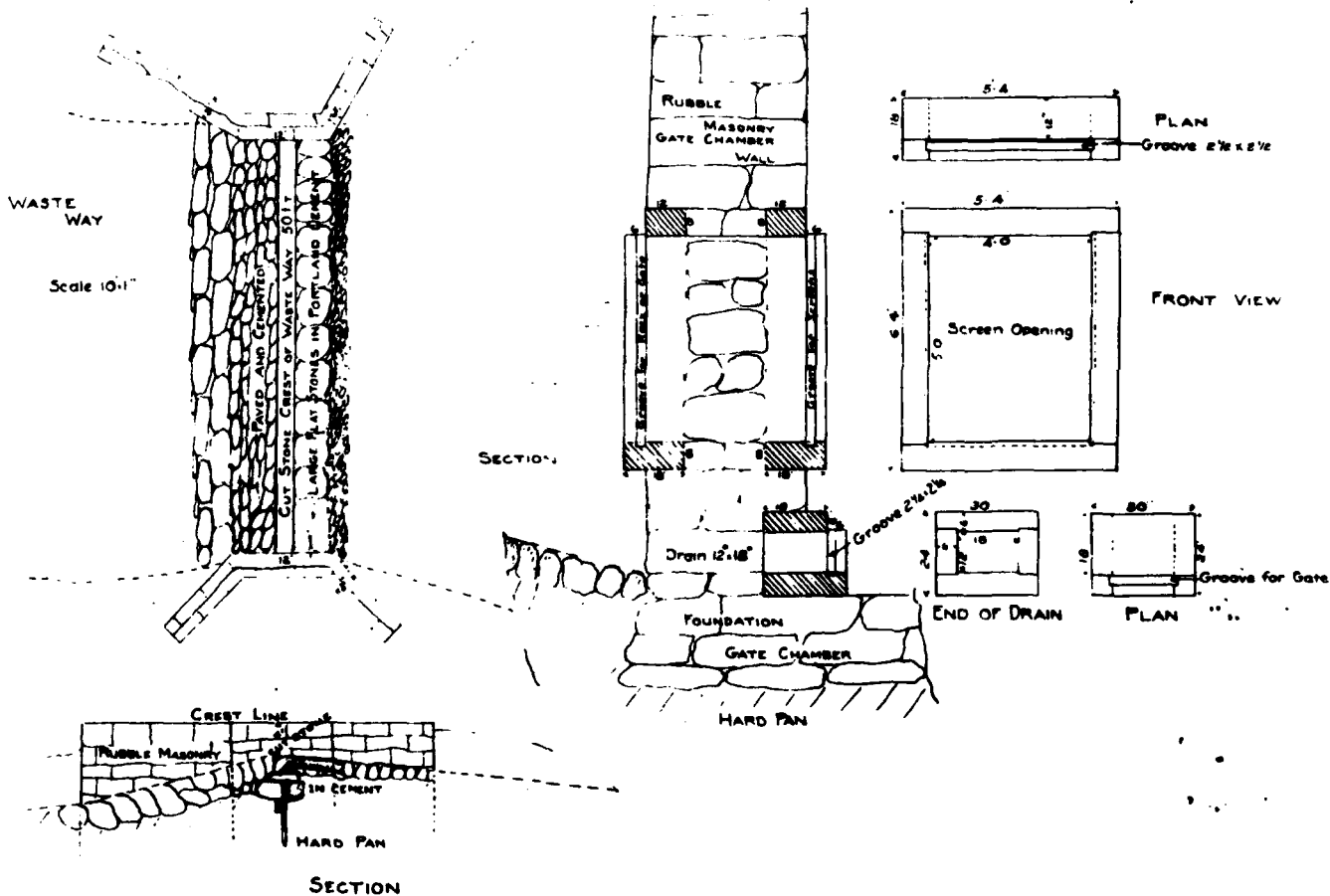
FRONT ELEVATION



PLAN



DETAILS OF CUT STONE
Scale 1/2" = 1'



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A. C. MOORE - Eng.
1898

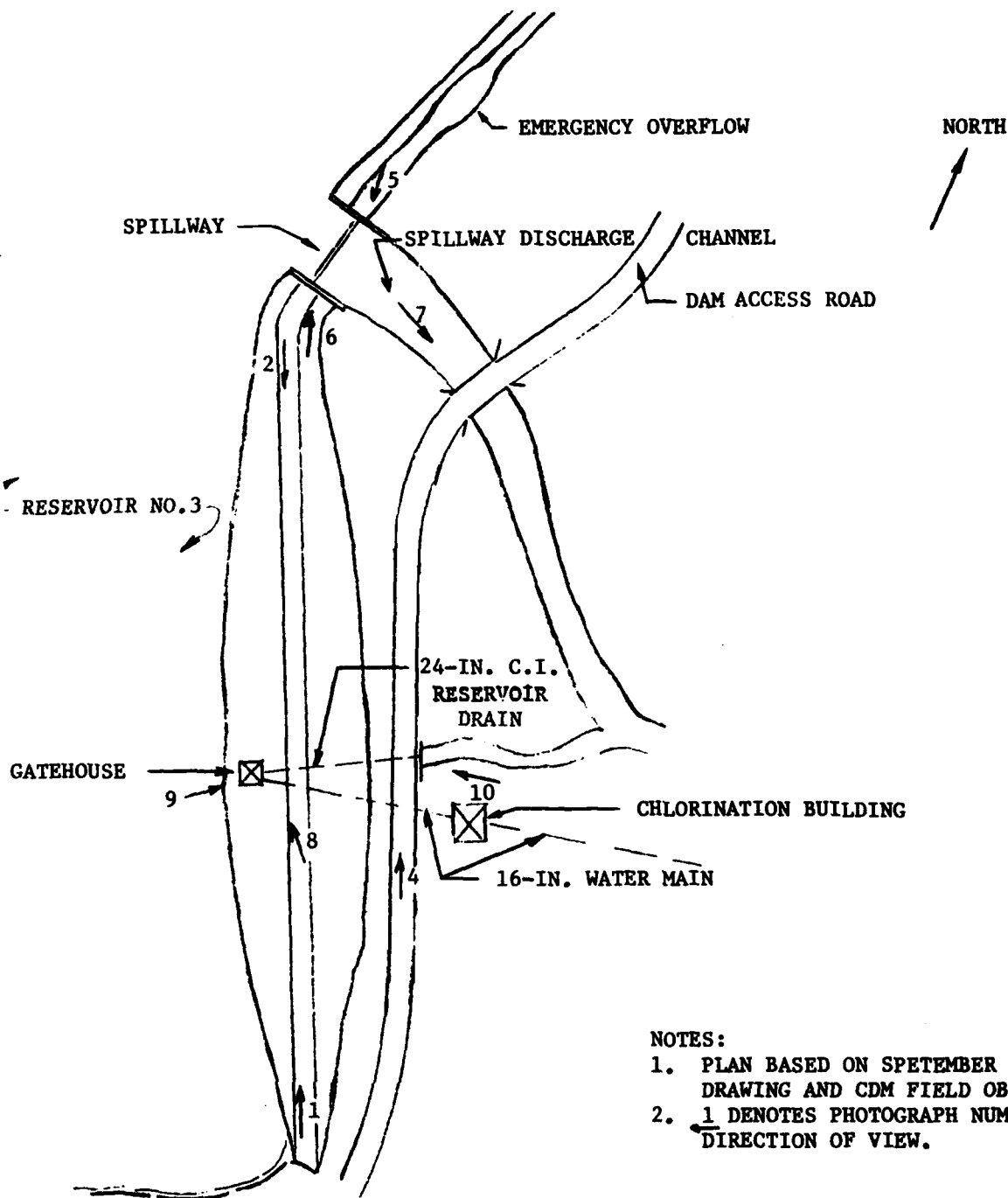
WORCESTER COUNTY COMMISSIONERS
WORCESTER COUNTY ENGINEERING DEPARTMENT
PLAN OF
STORAGE RESERVOIR
DAM
SOUTHBRIDGE MASS.
FOR THE SOUTHBRIDGE WATER SUPPLY CO.
AS FILED AND APPROVED BY THE
COUNTY COMMISSIONERS
DOCKET NO. 188
SCALE AS NOTED

TRACED BY L. C. FARRAR - MAR. 1940
TRACING CHECKED BY L. C. FARRAR - MAR. 1940 DAM NO. 44-18

APPROVED SEPT 12 1898

COPY

APPENDIX B-23



NOTES:

1. PLAN BASED ON SEPTEMBER 12, 1893
DRAWING AND CDM FIELD OBSERVATIONS.
2. 1 DENOTES PHOTOGRAPH NUMBER AND
DIRECTION OF VIEW.

CAMP DRESSER & MCKEE, INC.		U.S. ARMY ENG. DIV. NEW ENGLAND	
BOSTON, MASSACHUSETTS		CORPS OF ENGINEERS WALTHAM, MA.	
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS			
LOCATION OF PHOTOGRAPHS			
RESERVOIR NO. 3		SOUTHBRIDGE, MASSACHUSETTS	
			Scale: Not To Scale
			Date: Sept. 1979

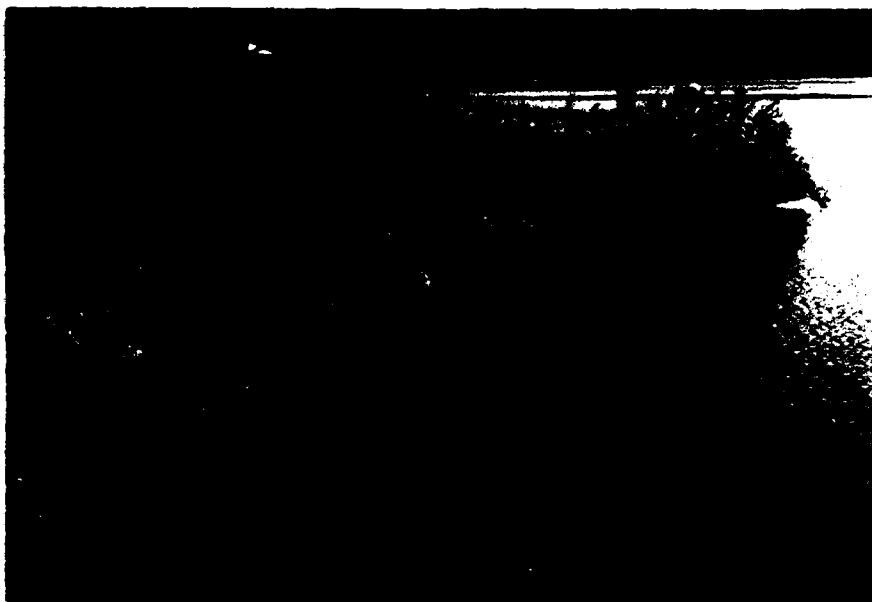
APPENDIX C-1



3. UPSTREAM FACE OF DAM.



4. DOWNSTREAM FACE OF DAM. NOTE EXPOSED AREA OF STABILIZING
STONE TO THE RIGHT OF THE POLE.



5. UPSTREAM FACE OF SPILLWAY. NOTE DAM EMBANKMENT IN UPPER LEFT OF PHOTO.



6. DOWNSTREAM FACE OF SPILLWAY.



7. SPILLWAY DISCHARGE CHANNEL, PHOTO LOOKING DOWNSTREAM FROM SPILLWAY.



8. OUTLET WORKS GATEHOUSE.



9. RESERVOIR DRAIN GATE OPERATOR IN GATEHOUSE.



10. DISCHARGE END OF RESERVOIR DRAIN DOWNSTREAM OF DAM.

APPENDIX D

HYDRAULIC AND HYDROLOGIC COMPUTATIONS

FIGURES

Drainage Area Map
Dam Failure Impact Area Map

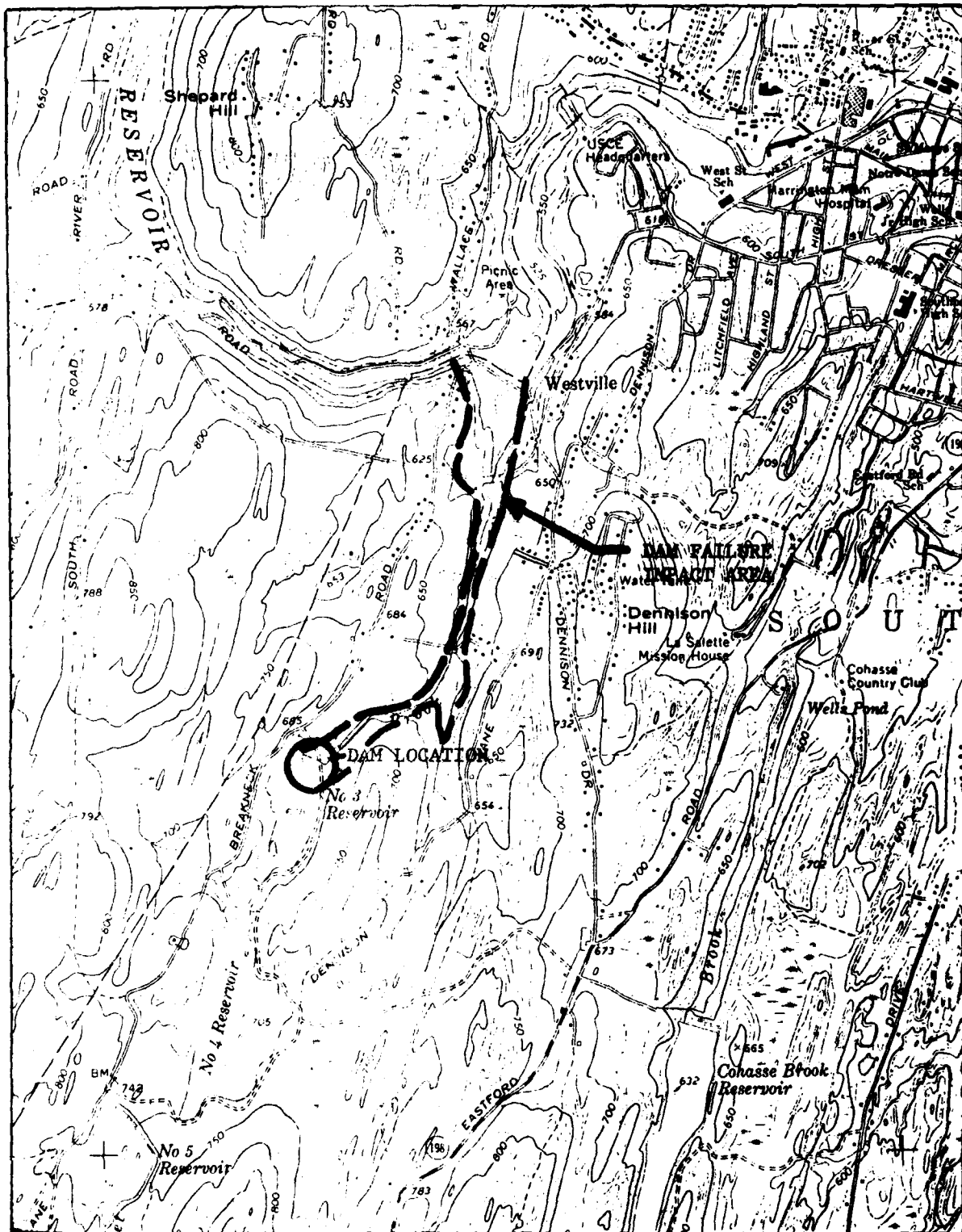
Page No.

D-1
D-2

COMPUTATIONS

Test Flood Development
Discharge and Storage Capacities
Surcharge-Storage Routing; Test Flood Analysis
Dam Failure Analysis

D-3
D-4 -5
D-6 -7
D-8



DAM RESERVOIR NO. 3

IDENTIFICATION NO. MA



DAM FAILURE IMPACT AREA MAP
USGS QUADRANGLE

SOUTHBRIDGE, MA-CONN.

APPROX. SCALE: 1" = 2000'

CLIENT COEJOB NO. 380-6-RT-8PAGE 1PROJECT Dam InspectionDATE CHECKED 9-12-79DATE 9-7-79DETAIL Reservoir No. 3CHECKED BY JEDCOMPUTED BY Joe A.ELEVATIONS

Spillway Crest 678.0
 Crest of Dam 681.3
 Toe of Dam @ Inv. of Reservoir Drain Channel 657.0 ±

Elevations based on National Geodetic Vertical Datum.

SURFACE AREAS

Drainage Area ≈ 2.37 sq. mi. ≈ 1520 acres; 76% ponded water; Average Slope ≈ 2.4 percent
 Reservoir Water Surface Areas:
 @ W.S.EI. 678 (spillway crest elev.) ≈ 22.0 acres
 @ W.S.EI. 680 ≈ 26.6 acres
 @ W.S.EI. 690 ≈ 35.8 acres

RESERVOIR STORAGE

from owner's records

@ Spillway Crest Elevation (678.0) $\approx 85,000,000$ gals ≈ 261 ac-ft
 @ W.S.EI. 680, storage $\approx 261 + \frac{(22 + 26.6)}{2} \times 2 \approx 310$ ac-ft
 @ W.S.EI. 690, storage $\approx 310 + \frac{(26.6 + 35.8)}{2} \times 10 = 622$ ac-ft

TEST FLOOD DETERMINATION

The dam size is "small" based on a height of 24 feet and a storage of 350 ac-ft. The hazard is "significant" based on the Dam Failure Analysis shown on page 5.

Therefore, based on the NED Corps of Engineers Guidelines, the Test Flood for Reservoir No. 3 is:

Test Flood ≈ 100 yr Flood to $\frac{1}{2}$ PMF
 USE $\frac{1}{4}$ PMF for Test Flood

The drainage area is mostly rolling terrain with a flat slope (2.4%) and a considerable amount of upstream ponded water (7.6% of the drainage area). In addition, another 2% of the drainage area is swamps. Using a point midways between the "Rolling" and "Flat Coastal" curves from NED

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Client: COE

Project: Reservoir No 3 Dam Safety Imp.

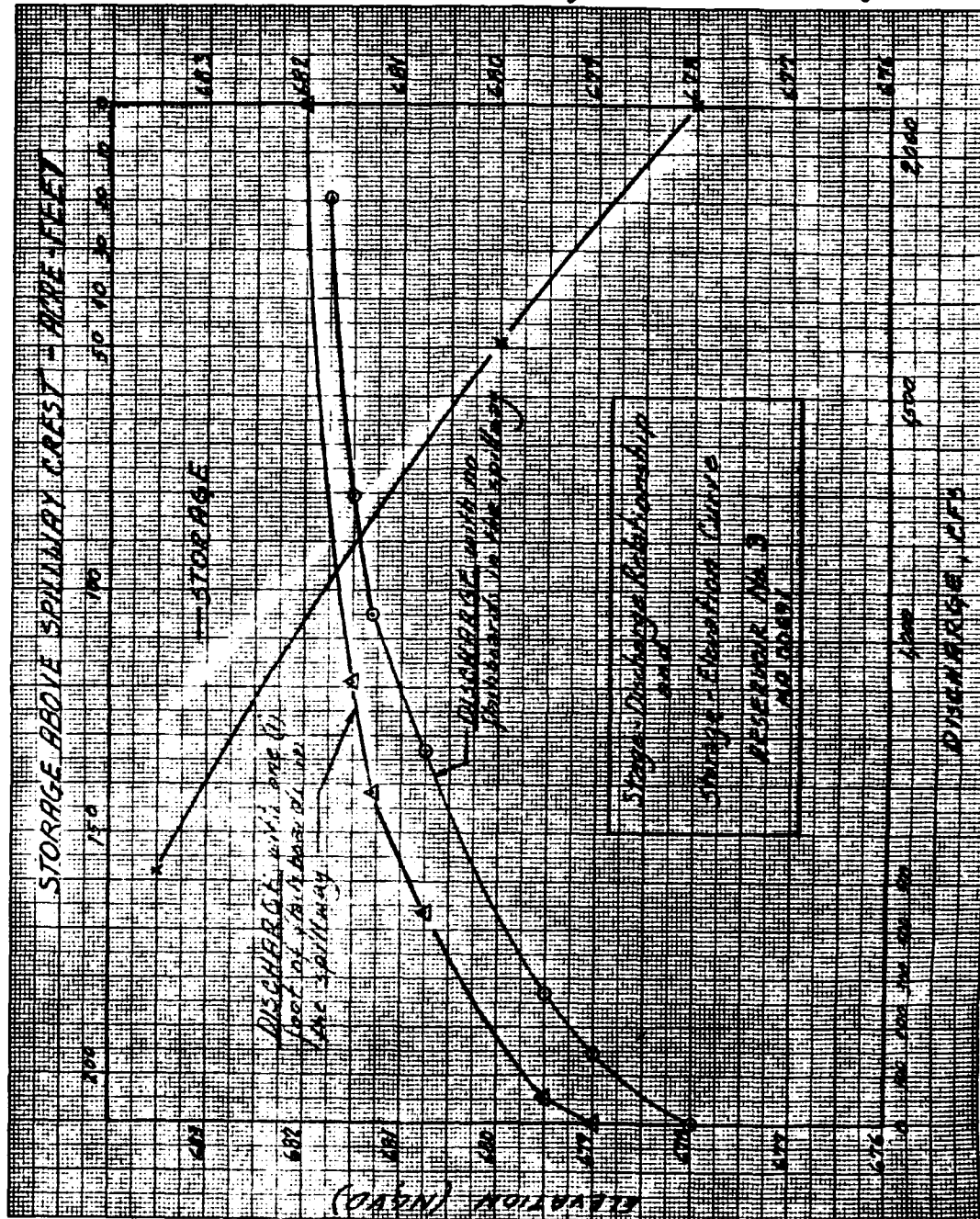
Lab. No. 380-6-RT-8

Calcd by: JED 9-12-79

Page: 3

Computed by: Joe A. 9-7-79

NO. 319-A, MILLIMETERS, 500 BY 500 DIVISIONS.
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APPENDIX D-4

Corps of Engineers "Preliminary Guidance for Estimating Maximum Probable Discharge in Phase I Dam Safety Investigation March 1978, The peak test flood inflow is:

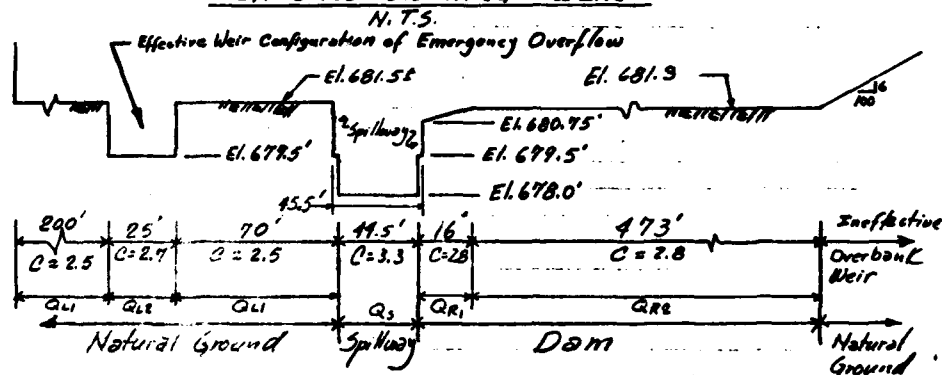
$$\frac{1}{4} PMF = \frac{1}{4} \left(\frac{1500 \text{ cfs}}{19 \text{ mi.}} \times 2.3719 \text{ mi.} \right) = 889 \text{ cfs}$$

say 890 cfs

STAGE-DISCHARGE RELATIONSHIP

I. Assume no flashboards in place; determine effective weir.

EFFECTIVE DISCHARGE WEIR



W.S. El. (NGVD)	Spillway Discharge Q _s	Rt. Embk. Discharge Q _{R1}	Left Embk. Discharge Q _{R2}	Total Discharge (cfs)
678.0	—	—	—	ZERO
679.0	147	—	—	147
679.5	270	—	—	270
680.75	674	—	—	768
681.3	888	6	—	1,050
681.5	971	15	118	1,295
682.0	1,188	43	776	2,512

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CLIENT COE
 PROJECT Dam Inspection
 DETAIL Reservoir No. 3

JOB NO. 380-6-RT-B
 DATE CHECKED 9-12-79
 CHECKED BY JED

PAGE 4
 DATE 9-7-79
 COMPUTED BY h.e. R.

SURCHARGE-STORAGE ROUTING

Test Flood Inflow, $Q_p = 890$ cfs (see page 2 for Test Flood Determination)

Surcharge height to pass Q_p is El. 680.78

$$STOR_1 = \frac{\text{Surcharge Storage}}{\text{Drainage Area}} = \frac{76 \text{ ac-ft} \times 12 \text{ in/ft}}{1520 \text{ acres}} = 0.60 \text{ inches}$$

$$\text{Probable Maximum Runoff, } Q_p = Q_p \left(1 - \frac{STOR_1}{4.75}\right) = 890 \left(1 - \frac{0.60}{4.75}\right) = 778 \text{ cfs}$$

Surcharge height to pass Q_p is El. 680.78

$$STOR_2 = \frac{70.0 \times 12}{1520} = 0.55 \text{ inches}$$

$$STOR_{avg} = \frac{0.60 + 0.55}{2} = 0.575 \text{ inches}$$

$$Q_p = 890 \left(1 - \frac{0.575}{4.75}\right) = 782 \text{ cfs, say } 785 \text{ cfs}$$

Surcharge Height to pass Q_p is El. 680.8

∴ Test Flood Inflow = 890 cfs

Routed Test Flood Outflow = 785 cfs $\left\{ \begin{array}{l} 670 \text{ cfs through spillway} \\ 95 \text{ cfs through emergency overflow} \end{array} \right.$

Surcharge Elevation = 680.8

... OTHER KEY DISCHARGES

Outlet Works Capacity at Test Flood El. (680.8) $= Q_c \cdot CAV \sqrt{2gh} = 20 \text{ (ft}^2) \sqrt{64.1 (28)} = 97, \text{ say } 100 \text{ cfs}$

Spillway discharge at top of dam (elev. 681.3) = 1,075 cfs (interpolated)

TAILWATER ANALYSIS

Normal depth in spillway discharge channel is about 0.75'

$$\text{Critical depth is } Y_c = \left(\frac{(785)^2 \times 1}{9.8 \times 37.2} \right)^{1/3} = 2.1 \text{ ft}$$

∴ flow is supercritical and there is no tailwater at the spillway

The access road to the dam crosses the spillway discharge channel at the toe of the dam over a concrete culvert (9H x 13.5W). The culvert would not be overtopped by the Test Flood Event, and there would be no tailwater effects at the spillway as a result.

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II. Assume maximum height of flashboards in the spillway i.e. 12" of flashboards.

W.S. El. (NGVD)	Spillway Discharge Q_s	Rt. Embankment Q_{R1}	Left Embankment Q_{R2}	Q_{L1}	Q_{L2}	Total Discharge (cf)
678.0	0	-	-	-	-	ZERO
679.0	0	-	-	-	-	ZERO
679.5	52	-	-	-	-	52
680.75	344	-	-	-	94	438
681.3	520	6	-	-	156	682
681.5	590	15	118	-	191	914
682.0	776	43	776	238	267	2,100

SURCHARGE-STORAGE ROUTING w/ 1-foot of flashboards in place at the spillway.

Test Flood Inflow, $Q_p = 890$ cfs (see page 2)

Surcharge height is El. 681.50

$$STOR_1 = \text{Surcharge Storage/Drainage Area} = 91 \text{ ac} \cdot \text{ft} \times 12 \text{ in} / 1520 \text{ ac} \cdot \text{in} = 0.718 \text{ inches}$$

$$\text{Probable Max Runoff} = Q_p = Q_p(1 - (STOR_1/4.75)) = 890(1 - (0.718/4.75)) = 755 \text{ cfs}$$

$$\text{Related Surcharge height is } 681.37; STOR_2 = 87 \times 12 / 1520 = 0.687 \text{ inch}$$

$$STOR_{avg} = (0.718 + 0.687) / 2 = 0.703 \text{ inches}$$

$$Q_p = 890(1 - (0.703/4.75)) \approx 760 \text{ cfs}; \text{ Surcharge El. is } 681.38$$

$$\therefore \text{Test Flood Inflow} = 890 \text{ cfs}$$

$$\text{Routed Test Flood Outflow} = 760 \text{ cfs} \begin{cases} 550 \text{ cfs through spillway} \\ 170 \text{ cfs through emergency overflow} \\ 40 \text{ cfs over the dam} \end{cases}$$

$$\text{Surcharge Height El.} = 681.4$$

but the Outlet Works Capacity @ Test Flood El. ≈ 100 cfs, which would indicate that the dam would not be over-topped if flashboards were in place and the outlet works were open.

DAM FAILURE ANALYSISdetermine Q_p

$$Q_p = \frac{8}{27} (W_b) (g)^{1/2} (Y_o)^{3/2}$$

where: W_b = 10% of the width of the dam
measured at mid-height
= $990 \times 0.4 = 196$ ft.

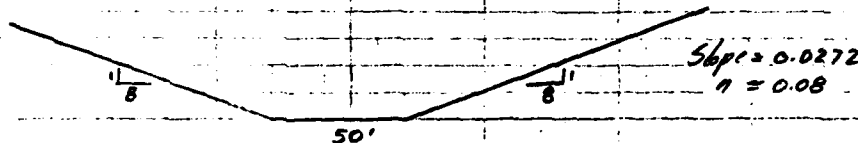
$$g = 32.2 \text{ ft/sec}^2$$

Y_o = Height of dam measured from
toe of O/S slope to top of
dam crest = 24 feet

$$Q_p = \frac{8}{27} (196) (32.2)^{1/2} (24)^{3/2} = 38,746, \text{ say } 38,750 \text{ cfs}$$

REACH 1: Dam to unnamed street which cross-connects
Darnison Lane to Breakneck Rd.

Estimated Cross section of Channel 100-ft U/S and
100-ft O/S of Roadway embankment.



Determine depth of flow:

<u>Y, ft</u>	<u>X-Sect Area, ft²</u>	<u>Flow, cfs</u>
15	2550	33,350
20	4200	65,200

To pass 38,750 cfs, depth of Water \approx 15.9 ft.
Assume that 750 cfs is stored in reach.

CAMP DESIGNER & ENGINEER INC.

CLIENT COE

JOB NO 380-6-REB

PAGE 7

PROJECT Dam Exp.

DATE CHECKED 9-12-79

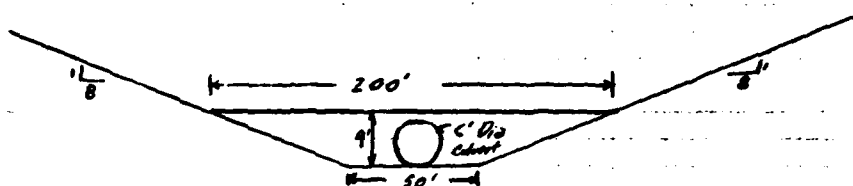
DATE 6-19-79

DETAIL Reservoir No. 2 Dam

CHECKED BY JED

COMPUTED BY Joe H.

Estimated X-Section at Roadway Embankment:



Neglect head loss between a section just upstream of the roadway embankment and compute depth of water over the roadway.

1. Energy @ upstream section

$$E = y + \frac{V^2}{2g} = 15.9 + \frac{(38,000)^2}{2 \times 32.2 \times 2583} = 19.3' \text{ of water}$$

2. Compute minimum Energy to pass 38,000 cfs over roadway embankment.

$$E = 9 + y + \frac{V^2}{2g}$$

@ a depth over the roadway ≈ 9 ft, flow through the culvert is

$$Q = CA \sqrt{2gh}$$

$$= 0.85(28) \sqrt{64.4(15)} = 750 \text{ cfs.}$$

\therefore flow over the roadway $\approx 37,250$ cfs.

Depth of Flow, ft.	Energy, Ft.-H ₂ O
7	$9 + 7 + 6.7 = 22.7$
8	$9 + 8 + 4.8 = 21.8$
8.5	$9 + 8.5 + 4.2 = 21.7$
9	$9 + 9 + 3.6 = 21.6$
10	$9 + 10 + 2.7 = 21.7$

The minimum Energy required to pass 38,000 cfs over the roadway embankment ≈ 21.6 -ft of H_2O .

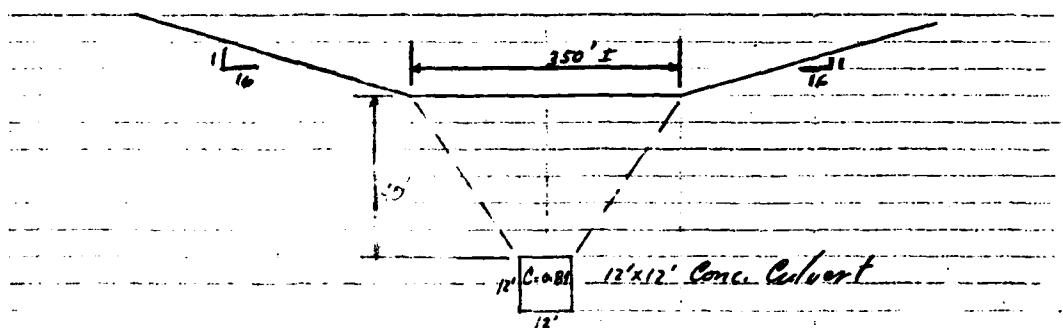
Therefore, water will back upstream to a total energy of 21.6 ft minimum

$$E = 21.6 = y + \frac{V_{avg}^2}{2g} \quad \therefore y_{avg} \approx 20 \text{ to } 21 \text{ feet}$$

Damage in reach 2 is estimated at one roadway and two ohlone bldg.

REACH 2: Reach 1 to Mashapung Road.

Estimated X-Section



Depth of Water Ct of Culvert	Office Flow (cfs)	Weir Flow, C=2.8		Total Flow (cfs)
Flat Weir	Inclined Weir			
52	7,000	0	0	7,000
57	7,300	10,950	1,750	20,000
62	7,650	31,000	10,000	48,650

Depth of water over Mashapung Road would be about 8.3 feet. There would be about 2.5 feet of water above the sill of a house on the left bank.

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Beyond Mashopaug Road, the dam failure outflow would be attenuated in the Corps of Engineers Westville Reservoir flood control project without further hazard to structures and residences. However, the flood control area is used as a park and a dam failure outflow would endanger users of the park.

Conclusions:

A dam failure of Reservoir No. 3 would overtop two roadways, flood two chlorine buildings which would disrupt water supply to Southbridge, and flood one residence. In addition, users of the Westville Reservoir flood control area would be endangered. Therefore, the

hazard is "significant"



INVENTORY OF DAMS IN THE UNITED STATES

STATE	IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR DIST.	STATE	COUNTY	CONGR DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE
DAY	MO	YR										
MA	691	NEU	MA	027	02				RESERVOIR NO. 3 DAM	4203.4	7204.4	24SEP79

POPULAR NAME	NAME OF IMPOUNDMENT
	RESERVOIR NO. 3

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	07	HATCHET BROOK	SOUTHBRIDGE	1	16910

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCT. HEIGHT (FT.)	HYDRAU. HEIGHT (FT.)	IMPOUNDING CAPACITIES		DIST OWN	FED R	PRV/FED	SCS A	VER/DATE
					MAXIMUM (ACRE-FT.)	NORMAL (ACRE-FT.)					
REPGOT	1894	8	24	24	350	261	NEU	N	N	N	N

REMARKS
21-CONCRETE CORE WALL

D/S HAS	SPILLWAY		MAXIMUM DISCHARGE (CFS)	VOLUME OF DAM (CU YD)	POWER CAPACITY		NAVIGATION LOCKS												
	CREST LENGTH	TYPE			WIDTH (FT.)	INSTALLED (MW)	PRODUCED (MW)	NO.	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)					
2	490	U	45	890															

OWNER	ENGINEERING BY	CONSTRUCTION BY
SOUTHBRIDGE WATER SUPPLY	A C MOORE, ENGINEER	

REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	NONE

INSPECTION BY	INSPECTION DATE	AUTHORITY FOR INSPECTION
DAY	MO	YR
CAMP DRESSER + MCKEE INC	13AUG79	PUBLIC LAW 92-367

REMARKS
46- CO.

DATE
FILMED
-8